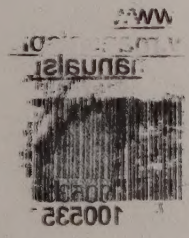
INSTRUCTION MANUAL

MODEL 4200 RF MICROWATTMETER



MP MASTER
MA24750

4200 TEMP.

BOONTON ELECTRONICS CORPORATION

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SECTION I

PERFORMANCE SPECIFICATIONS

Frequency Range: 200 kHz to 18 GHz (depending on power sensor used).

Power Range: (Display calibrated in mW, µW, nW, dBm and dBr relative to an arbitrary reference):

With all 4200-4 Series power sensors: 70 dB dynamic range with 7 full-scale ranges of -50, -40, -30, -20, -10, 0, and +10 dBm (10 nW to 10 mW)

With all 4200-5 Series power sensors: 70 dB dynamic range with 7 full-scale ranges of -40, -30, -20, -10, 0, +10, and +20 dBm (100 nW to 100 mW)

With 4240 Thermocouple power sensor: (10 MHz to 18 GHz) 40 dB dynamic range with 4 full-scale ranges of -20, -10, 0, and +10 dBm (10 µW to 10 mW)

Ranging: Autoranging plus hold-on-range

Accuracy, Instrumentation:

	> 10 nW (100 nW with 4200-5 sensors)	< 10 nW (100 nW with 4200-5 sensors)
Watt Mode	± 1.2% rdg ± 1 digit	± 1.5% rdg ± 1.5% fs
dB Modes*	$0.05\ dB \pm \frac{dB_{fs} - dB_{rdg}}{200}$	$\pm\ 0.1\ dB \pm \frac{dB_{fs} - dB_{rdg}}{20}$

*except in Channel 3 operation with option -03 where the accuracy statement must be multiplied by a factor of two.

Accuracy, Instrumentation (Continued):

Zero: Automatic, operated by front-panel key switch

Zero drift:

With 4200-4E series power sensors: 1 nW/hr. max. on 10 nW range.

With 4200-5E series power sensors: 10 nW/hr. max. on 100 nW range.

Temperature influence:

Range	Instrument	4200-4/4200-5
21°C to 25°C	0	0 dB
18°C to 30°C	0	± 0.1
10°C to 40°C	± 0.2 dB	± 0.2

Power Reference: (Internal 50 MHz oscillator with Type N female connector on front panel)

Power output: 1.00 mW. Factor set to ±0.7%, traceable to National Bureau of Standards.

Accuracy: ± 1.2% worst case for one year (0°C to 55°C).

Calibration: Front panel key switch automatically calibrates instrument to power reference.

General:

Cal Factor: Range, 1.25 dB to -1.25 dB in 0.01 dB steps - entered via front panel keys. Stored Cal Factors: Linearly interpolated and automatically applied

Cal Factor (Continued):	to readings when frequency is entered via front panel keys. Nine individual cal factors for up to 4 interchangeable power sensors are stored in a non-volatile memory.
Waveform response:	With 4200-4 Series power sensors: true average power to 20 µW; above 20 µW, average power of sine wave.
	With 4200-5 Series power sensors: true average power to 200 µW; above 200 µW, average power of sine wave.
	With 4240 power sensor: true average power.
Response time:	Typically 0.7 second. Varies with power level and amount of power change.
Recorder output:	Watt mode: 10 V full scale proportional to indicated power over each range.
	dB mode: 8 V equivalent to 0 dBm with a sensitivity of 1 V per 10 dB change over the entire range.
Display:	4 digit LED, 3-1/2 digit display of power; 4 digit display of dB with 0.01 dB resolution.
	Auxiliary analog display, uncalibrated, proportional to power (watt mode) or dB (dB modes).
Annunciators:	LED display of mW, µW, nW, dBm, or relative dB (dBr). LED indicates use of Channel 1 (CH1), Channel 2 (CH2 option -03), Channel 3 (CH3 = CH1 - CH2 in dB), out of dB limits, and condition of IEEE-488 bus activity, LSN, ATN, REM, TLK (option -01).

Power consumption: 100, 120, 220, 240 V; 50 - 400 Hz; 24 VA

Weight: ≈ 10 lbs. (4.54 kg)

Battery option, 5 lbs. additional (2.3 kg)

Size: 8.3" wide (21.1 cm)
5.85" high (14.9 cm)
13.75" long (34.9 cm)

Accessories furnished: 5 foot power sensor cable Model 41-2A with each channel ordered.

Accessories required: one or more of the following power sensors:

	Boonton, 41-4 Series				Boonton, 41-5 Series		General Microwave 4240 Series, modified
Model	41-4A	41-4B	41-4C	41-4E	41-5B	41-5E	N4240
Input	50 Ω	50 Ω	75 Ω	50 Ω	50 Ω	50 Ω	50 Ω
Frequency Range	200kHz-7GHz	200kHz-12.4GHz	200kHz-1GHz	200kHz-18GHz	200kHz-12.4GHz	200kHz-18GHz	10 MHz-18 GHz
Cal. Factor Uncertainty	10 nW to 10 mW fs				100 nW to 100 mW fs		10 μW to 10 mW fs
	3.0%, 200 kHz-4 GHz 3.5%, 4 GHz-8 GHz 4.0%, 8 GHz-10 GHz 4.5%, 10 GHz-12 GHz 6.0%, 12 GHz-18 GHz						
		Add 0.05 dB/mW above 4 GHz			Add 0.005 dB/mW above 4 GHz		
Max. SWR	1.12, 200kHz-2GHz 1.2, 2GHz-4GHz 1.4, 4GHz-7GHz	1.12, 200kHz-2GHz 1.2, 2GHz-4GHz 1.4, 4GHz-11GHz 1.6, 11GHz-12.4GHz	1.18, 200kHz-1GHz	1.3, 200kHz-4GHz 1.5, 4GHz-10GHz 1.7, 10GHz-18GHz	1.07, 200kHz-1GHz 1.10, 1GHz-2GHz 1.12, 2GHz-4GHz 1.18, 4GHz-12.4GHz	1.07, 200kHz-1GHz 1.10, 1GHz-2GHz 1.12, 2GHz-4GHz 1.18, 4GHz-12.4GHz 1.28, 12.4GHz-18GHz	1.5, 10 MHz — 15 MHz 1.35, 15 MHz — 10 GHz 1.6, 10 GHz — 18 GHz
Max. Average Power	300 mW (+25 dBm)				2 W (+33 dBm)		40 mW (+16 dBm)*
RF Connector	Precision Type N male						
Calibration Factor	Individually calibrated at 1 GHz, and 2 GHz to 18 GHz in 2 GHz increments						

*While this sensor will withstand short periods of overload, extended overload operation may result in permanent change in characteristics, or even burnout.

Accessories available:

P/N 950000: rack-mounts one Model 4200, placed either right or left on a 19-inch spacing.

P/N 950001: Rack-mounts two instruments, side-by-side.

Options:

-01 IEEE 488 Bus Interface. Duplicates all front-panel functions except on/off power switch and power reference switch. Outputs all range data and status information.

-02 Battery operation, 8 hours on for 14 hours charge. Precludes use of option -03.

-03 Input Channel 2. Allows display of either Channel 1 or Channel 2, or Channel 3 which is Channel 1 minus Channel 2, expressed in dB. Requires use of two power sensors. Precludes use of option -02.

-04 Rear input. Duplicates front-panel Channel 1 input connector.

-05 Swing-tilt handle.

SECTION II

OPERATION

2.1 GENERAL.

2.2 This section provides instructions for installation and operation of the instrument. Although the design of the instrument emphasizes ease of operation, it is recommended that the operator familiarize himself thoroughly with the material in this section before attempting to operate the instrument; otherwise, the full capabilities of the instrument may not be realized in use.

2.3 INSTALLATION.

2.4 Unpacking. The instrument is shipped complete, with sensors if ordered, and is ready for use upon receipt. Unpack the instrument carefully, and inspect it for any signs of shipping damage. Should any damage be noted, notify the carrier and the factory immediately.

NOTE: Save the packing material and container for possible use in reshipment of the instrument.

2.5 Mounting. For bench use, choose a clean, sturdy, uncluttered surface. For rack mounting, an accessory package, P/N 950000, is available to mount one instrument. Another accessory package, P/N 950001, mounts two instruments side-by-side.

2.6 Power Requirements. The instrument has a tapped power transformer which permits operation from 100, 120, 220, or 240 volts ± 10%, 50 to 400 Hz, single phase AC power sources. Power consumption is approximately 24 volt-amperes at 60 Hz.

NOTE: If the instrument is equipped with Option -02, it can also be operated from an internal 13 volt battery (supplied as part of the option). AC power sources listed may be used to recharge the battery, or as an alternate power source.

2.7 Cable Connections. Interconnecting cable connections required depend upon the options installed and the system applications of the instrument. A line cord and sensor cable are supplied with the instrument; an IEEE-488 interface cable is supplied with Option -01; any other cables required must be supplied by the user. Cable connections that may be required are as follows:

a. Sensors. The sensor cable supplied with the basic instrument connects directly to the front-panel SENSOR connector, and the sensor that is to be used for power measurements connects directly to the other end of the sensor cable. Although the sensors are insulated against extreme temperature variations, it is advisable to locate the sensor away from heat sources when using the most sensitive ranges of the instrument. If the instrument is to be used to measure the output of equipment that generates heat significantly above the ambient temperature, a short length of coaxial cable having the same characteristic impedance as the sensor may be used between the sensor and the equipment undergoing test to allow for circulation of air around the sensor. If such a cable is used, the length must be kept as short as possible, and operation should not be attempted at the high end of the frequency range; cable losses and an increase in VSWR will tend to degrade measurement accuracy.

NOTE: The front-panel SENSOR connector is the input connector for Channel 1 measurements. If the instrument is equipped with Option -03, a sensor may be connected to the rear-panel connector marked SENSOR; the same conditions apply to this sensor connection. The rear-panel connector marked SENSOR represents the input connector for Channel 2 measurements.

b. Recorder Output. Rear panel connector J20 (type BNC) provides an analog dc voltage that is proportional to measured power (Power Mode) over each instrument range or proportional to dB (dB Mode) over the entire range. Full scale dc voltage in power mode is 10 volts. In dB mode, +8 V corresponds to 0 dBm, and the sensitivity is 1 V per 10 dB change. Output impedance is approximately 9000 ohms. Maximum current capability is 1 milliampere into 1000 ohms.

c. Status Output. Rear-panel connector P3 provides signal outputs for input disconnect during zeroing operations and high and low dB limit signals during dB measurements. Pin connections are as follows:

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CONNECTOR PIN	SIGNAL
1	Common
2	Not used
3	Logic high indicates zeroing operation
4	Logic low within dB limits; logic high above high dB limit
5	Logic low within dB limits; logic high below low dB limit

2.8. OPERATING CONTROLS, INDICATORS, AND CONNECTORS.

2.9. Controls, indicators, and connectors used during operation of the instrument are shown in Figures 2-2 and 2-3. Table 2-1 lists their functions.

2.10. FIELD ENTRY OF SENSOR CALIBRATION DATA.

2.11. Calibration corrections for sensors ordered with the instrument are written into non-volatile memory at the factory before shipment. When the CAL FACTOR GHz function of the instrument is used during measurement, the microprocessor reads and interpolates the stored data on the basis of the specified measurement frequency, and corrects all measurement values accordingly. The non-volatile memory has storage capacity for calibration data for up to four sensors. Calibration corrections vary for different sensors; therefore, if sensors are to be substituted or added in the field, calibration data for these sensors must be written into memory in the field in order for the CAL FACTOR GHz function to be accurate.

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

CONTROL, INDICATOR, OR CONNECTOR	FIGURE & INDEX NO.	FUNCTION
LSN, ATN, REM, TLK ANNUNCIATOR		Provide indication of activity when IEEE 488 Bus Interface (Option -01) is in use.
METER		Provides relative indication of power for peaking and nulling operations.
CH1, CH3, CH2		Indicate channel in use.
MODE KEYS		Select display indication mode, power, or dB.
RANGE KEYS		Select ranging mode, auto or hold on range.
LED DISPLAY		Four digit LED display with minus sign and decimal points provides numeric indication of power, dB, and data entered or recalled via keyboard.
mW, µW, nW ANNUNCIATORS		Indicate units of power in power mode.
LIMITS dB KEYS		Provide means for entering and recalling dB limits.
dBm, dBr ANNUNCIATORS		Indicate dB reference in use.
LIMIT ANNUNCIATOR		Indicates when power level is outside dB limits selected.
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TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONTINUED)

CONTROL, INDICATOR, OR CONNECTOR	FIGURE & INDEX NO.	FUNCTION
CAL FACTOR KEYS		Provide means for entering or recalling cal factors in terms of dB or frequency.
SELECT KEYS		Provide means for entering or recalling channel and sensor number.
dB REF LEVEL KEY		Provides means for entering or recalling a dB reference level.
NUMERICAL, DECIMAL POINT, CHS KEYS		Provide means for entering signed numeric data.
LINE SWITCH		Controls application of ac line power to instrument. *NOTE: If LINE switch and BATTERY are both set to ON position simultaneously with instrument connected to ac power source, LINE switch overrides BATTERY switch; if both are set to ON position with instrument not connected to ac power source, instrument remains off.*
BATTERY switch		Three position switch which controls instrument operation from battery source (if instrument is equipped with battery option). Instrument is powered from battery when BATTERY switch is set to ON position and LINE switch is set OFF position. With BATTERY switch set to CHG position and LINE switch set to ON position, battery is recharged from ac power source through instrument power supply.

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONTINUED)

CONTROL, INDICATOR, OR CONNECTOR	FIGURE & INDEX NO.	FUNCTION
POWER REF ON switch		Permits operator to turn reference power source on and off.
SENSOR connector		Provides means for connecting sensor cable to Channel 1 input of instrument.
CAL key		With sensor connected to POWER REF 1.00 mW, 50 MHz connector, POWER REF ON switch set to ON, and proper channel selected through keyboard, pressing CAL key initiates automatic calibration of sensor and instrument.
ZERO key		Provides means for automatically acquiring and storing zero corrections for each range.
Line Connector		Provides means for connecting instrument to ac power source; contains power fuse and voltage change card for 100, 120, 220, or 240 volt ac operation.
P3 connector		Provides logic signal outputs for input disconnect during zeroing, high dB limit, and low dB limit.
J20 connector		Provides analog dc output which is proportional to measured power level or dB for application to recorder.
J1 connector		Option: provides IEEE-488 bus connections when Option -01 is installed.

TABLE 2-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONTINUED)

CONTROL, INDICATOR, OR CONNECTOR	FIGURE & INDEX NO.	FUNCTION
S1 switch		Used to set address of instrument when IEEE-488 bus Option -01 is installed.
SENSOR connector		Provides means for connecting sensor No. 2 when Option -03 is installed.

2.12 POWER APPLICATION.

2.13 The basic instrument is designed for operation from a 100, 120, 220, or 240 volt, 50 to 400 Hz, single phase, ac power source. To apply ac power, proceed as follows:

a. Determine the line voltage at the ac power output receptacle.

b. Slide the plastic cover on the rear-panel power assembly so that the section that houses the fuse is uncovered. Look at the small printed circuit card located below the fuse, and note the voltage marking at the left corner of the printed circuit card. If the voltage marking agrees with the voltage of the ac power source, the instrument is ready for power application. If the voltage marking does not agree with the voltage of the ac power source, remove the printed circuit card with small pliers and rotate and/or turn the printed circuit card so that the voltage marking in the left corner agrees with the voltage of the ac power source; insert the printed circuit card in this position.

c. Check the rating of the fuse in the rear-panel fuseholder. For 100 or 120 volt operation, the fuse should be a 0.3 ampere, MDL Slo-Blo type; for 220 or 240 volt operation, it should be a 0.2 ampere, MDL Slo-Blo type. If the rating of the fuse is incorrect, install a fuse of the required rating in the fuseholder. Slide the plastic cover back over the fuseholder.

WARNING: This instrument is designed to operate from a 3-terminal (one ground) ac power receptacle. If only a 2-terminal ac power receptacle is available, use a 3-prong to 2-prong adapter to eliminate a potential shock hazard to the operator. Connect the ground wire of the adapter to the power receptacle ground.

d. Connect the power cord between the ac power connector on the rear panel of the instrument and the ac power receptacle (with adapter, if necessary).

NOTE: If the instrument is equipped with Option -02, it may be operated from an internal battery. For such operation, it need not be connected to an ac power source; however, if the battery recharging capability is desired, connection to a suitable ac power source is required, and the procedures of preceding Steps (a) through (d) apply.

2.14 PRELIMINARY CHECK OF INSTRUMENT.

NOTE: The following checkout procedure is intended merely to demonstrate that the major circuits of the instrument are operating before the instrument is placed in service. For a detailed check of the instrument against performance specifications, refer to Paragraph

2.15 To perform a preliminary operational check, proceed as follows:

a. If the instrument is to be operated from an ac power source, set the LINE switch to the ON position and set the BATTERY switch to the OFF (down) position; if it is to be operated from the internal battery (Option -02), set the LINE switch to the OFF (down) position and set the BATTERY switch to the ON position.

NOTE: If the LINE switch and the BATTERY switch are both set to the ON position, the LINE switch overrides the BATTERY switch and the instrument operates from the ac power source.

b. Check operation of the LED display and the numerical keys by pressing the following keys in the sequence indicated and noting the LED display:

PRESS	DISPLAY
CLR	0000
.	0000.
0	000.0
1	00.01
2	0.012
3	.0123
CLR	0000
4	0004
5	0045
6	0456
7	4567
CLR	0000
8	0008
9	0089
CHS	-0089

c. Connect the sensor cable to the front-panel SENSOR connector, and connect the sensor to the free end of the sensor cable. Note the sensor number indicated on the barrel of the sensor, and enter this number through the numerical keyboard by pressing the numerical key corresponding to the sensor number and then pressing the SELECT SENS key. (Example: 2 SELECT SENS.)

d. Enter measurement parameters by pressing the following keys:

1 SELECT CHNL
0 CAL FACTOR dB
0 dB REF LEVEL dB
RANGE AUTO
MODE dB

e. Check to see that the dBm and CH1 annunciators are lit.

f. With zero input to the sensor, press the ZERO key. The zeroing cycle takes approximately 35 seconds. At the end of this period, the dBm annunciator should light again, and the front-panel display indication should be -cc03.

g. Connect the sensor to the POWER REF 1.00 mW, 50 MHz connector. Set the POWER REF ON switch to the ON position. The LED display should indicate approximately 00.00 dBm (assuming that a 50-ohm sensor is used).

h. Key in .2 CAL FACTOR dB through the keyboard. The LED display should change to approximately 00.20 dBm.

i. Key in 0 CAL FACTOR dB through the keyboard. The LED display should return to approximately 00.00 dBm.

j. Key in 1 CHS dB REF LEVEL dB through the keyboard. The LED display should indicate approximately 01.00 dBr.

k. Key in 1 dB REF LEVEL dB through the keyboard. The LED display should indicate approximately -01.00 dBr.

l. Key in 5 LIMITS dB HI. The LIM annunciator should remain off.

m. Key in 5 CHS LIMITS dB LO. The LIM annunciator should remain off.

n. Key in .5 CHS LIMITS dB HI. The LIM annunciator should remain off.

o. Key in .5 LIMITS dB LO. The LIM annunciator should be lit.

p. Key in 0 dB REF LEVEL dB. The LED display should indicate 00.00, the LIM annunciator should be off, and the dBm annunciator should be on.

q. Press the MODE PWR key; display should indicate ≈ 1.000 mW.

2.16. OPERATING PROCEDURES.

2.17 Programming Measurement Parameters.

a. General. Measurement parameters are entered into the microprocessor through the front-panel keyboard. In order to eliminate the need for repeated reprogramming, parameters entered through the keyboard are stored in nonvolatile memory, and the stored parameters are unaffected by instrument turn-off and turn-on. It is important to remember that the last used parameters are stored in the instrument because these stored parameters could cause what may appear to be erroneous indications when subsequent measurements are made. For example: if the instrument had been programmed for operation with sensor 2 and sensor 1 is used instead, the LED display may be inaccurate if a GHz calibration factor is entered because the sensor 2 calibration factors will be used by the microprocessor instead of the sensor 1 calibration factors. Whenever there is any doubt about any measurement parameter in storage, reprogram the instrument for the desired parameter. (Measurement parameters may be changed at any time.) Recall. The following keys may be used to recall the last entered value for that function:

LIMITS dB: Lo, HI
CAL FACTOR: dB, GHz
SELECT: SENS, CHNL
dB REF LEVEL: dB

b. Use of Numerical Keys. The numerical keys are used to enter numerical values for LIMITS dB, CAL FACTOR, SELECT, and dB REF LEVEL functions. Whenever any numerical key is pressed, the microprocessor interrupts the measurement operation to accept new data. Numerical values are entered in normal sequence, and keyed-in values enter the LED display from right to left. Up to four digits, plus decimal point and minus sign, can be entered; entries exceeding four digits are ignored. Pressing the decimal point key places a decimal point after the rightmost digit in the LED display. Pressing the CHS key changes the sign of the entry in the LED display; that is, plus becomes minus, or minus becomes plus. (The plus sign is not displayed.) If an error is made during entry of numerical values, press the CLR key and repeat the data entry process. When the LED display shows the desired numerical value, pressing the applicable LIMITS dB, CAL FACTOR, SELECT, or 4200 TEMP.

dB REF LEVEL key will cause the microprocessor to store the keyed in parameter and return automatically to the measurement cycle.

c. MODE Selection. The MODE keys enable the operator to select the desired measurement mode. When the MODE PWR key is pressed, measured power levels are displayed in mW, µW, or nW; the annunciators associated with the LED display indicate the appropriate unit. When the MODE dB key is pressed, measurement values are displayed in terms of dB with respect to an operator-entered dB reference level. If 0 dB has been chosen as the reference level, the displayed numerical values represent dBm, and the dBm annunciator is lit; selection of any other dB reference level causes lighting of the dBr annunciator, and displayed measurement values represent dB with respect to the selected reference level. Resolution of the instrument in the dB mode is 0.01 dB.

d. RANGE Selection. The RANGE keys enable the operator to select either automatic ranging or a range hold function. The automatic ranging function, which is most effective when measuring unknown or widely varying power levels, is activated by pressing the RANGE AUTO key, and the microprocessor then selects the appropriate measurement range automatically. If input power levels exceed the upper measurement limit of the instrument, an error indication cc04 appears on the LED display; if input power levels are below the low measurement limit of the instrument, the instrument displays cc03. Ranging time is a function of a number of factors such as absolute level, change in level, analog response time, and direction of change. The following tables list these times for 4200 Series sensors and the N4240 sensor.

RESPONSE TIMES, BUS OPERATION, 4200 SERIES POWER SENSORS

	FINAL RANGE						
INITIAL RANGE	10 mW	1 mW	100 µW	10 µW	1 µW	100 nW	10 nW
10 mW (+10 dBm)	0.5 sec.						
1 mW	0.5	0.4 sec.					
100 µW	0.6	0.5	0.5 sec.				
10 µW	0.8	0.6	0.6	0.5 sec.			
1 µW	0.9	0.8	0.8	0.6	1.4 sec.		
100 nW	1.1	0.9	0.9	0.8	1.9	5.8 sec.	
10 nW (-50 dBm)	1.3	1.2	1.2	1.0	1.9	5.0	15.0 sec.
10 mW (+10 dBm)	0.6	0.7	0.9	1.0	1.1	15.0	33.0
1 mW		0.7	0.7	0.8	0.9	5.0	27.0
100 µW			0.5	0.6	0.8	3.0	9.0
10 µW				0.7	0.7	4.0	3.0
1 µW					3.0	6.0	5.0
100 nW						6.0	5.0
10 nW (-50 dBm)							6.0 sec.

RESPONSE TIMES, BUS OPERATION, N4240 POWER SENSOR

	FINAL RANGE			
INITIAL RANGE	10 mW	1 mW	100 µW	10 µW
10 mW (+10 dBm)	2.0 sec.			
1 mW	2.0	4.0 sec.		
100 µW	2.0	3.0	2.0 sec.	
10 µW (-20 dBm)	2.0	2.0	8.0	7.0 sec.
10 mW (+10 dBm)	1.0	13.0	35.0	50.0
1 mW		4.0	13.0	11.0
100 µW			6.0	7.0
10 µW (-20 dBm)				7.0 sec.

The range hold function is useful when a series of measurements of approximately the same power level are to be made; selecting this mode eliminates delays due to ranging time. The range hold function is useful only in the PWR mode. When the RANGE HOLD key is pressed, the instrument remains on the measurement range that was active at the time the key was pressed. Input power levels that exceed the upper limit of this range cause an error indication on the LED display; input power levels below the low limit of this range result in fewer significant digits in the LED display.

e. LIMITS dB Selection. The LIMITS dB keys enable the operator to program high and low dB limits into the instrument. Input power levels outside these limits will cause lighting of the LIM annunciator and activation of out-of-limit signals at the rear-panel connector P3.

1. Limits are entered by keying in the numerical value in dB, using the numerical keys, and then pressing the LIMITS dB LO or LIMITS dB HI key, as applicable.

Example: to enter a low limit of -31.34 dB:

PRESS	DISPLAY
3	0003
1	0031
.	0031.
3	031.3
4	31.34
CHS	-31.34

LIMITS dB LO

2. The dB limits are always computed in terms of dBm, even when the dBr measurement mode has been selected. The dB limits must be entered as absolute levels, not relative levels. For example, if a dB reference level of -20 dB has been entered and dB limits equivalent to ± 3 dB indications on the LED display are desired, the high dB limit should be entered as +3 dB and the low limit should be entered as -3 dB.

3. The dB limit function is always operative in the instrument. For all practical purposes, it can be cancelled, if desired, by entering a high limit of 90 dB and a low limit of -90 dB.

f. CAL FACTOR Selection. The sensors used with the instrument are frequency sensitive; that is, with a constant input power level applied, their output signal level does not remain constant as the measurement frequency is changed. The CAL FACTOR keys provide means for introducing a calibration factor in terms of one of two parameters, either the actual dB calibration factor, or the measurement frequency.

1. A calibration chart is attached to the barrel of each sensor, and the calibration factor in dB for the measurement frequency being used can be computed from this chart. This dB calibration factor can then be entered into the instrument, using the numerical keys and the CAL FACTOR dB key, and the microprocessor will correct all subsequent measurements, both dB and power, automatically in accordance with the dB calibration factor entered.

Example: to enter a dB calibration factor of -0.3 dB:

PRESS	DISPLAY
.	0000.
3	000.3
CHS	-000.3
CAL FACTOR dB	

2. Reading and interpolation of the calibration chart can be tedious and subject to error or inaccuracy. The CAL FACTOR GHz function provides a simple,

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alternative method for calibration data selection. Calibration data for up to four sensors can be stored in the memory; such calibration data may be entered into storage at the factory or in the field. When the sensor number and the measurement frequency are entered through the keyboard, the microprocessor computes the required correction from the stored data, using the two closest points on either side of the entered frequency, does a straight-line interpolation, and corrects subsequent dB and power measurements accordingly. The sensor number is entered using the SELECT function described in Subparagraph g; the measurement frequency is entered using the numerical keys and the CAL FUNCTION GHz key.

Example: to specify a measurement frequency of 3.3 GHz:

PRESS	DISPLAY
3	0003
.	0003.
3	003.3
CAL FACTOR GHz	

g. SELECT Function. The SELECT keys are used by the operator to specify the number of the sensor to be used for measurements, and the measurement channel.

1. Calibration data for up to four sensors can be stored in the non-volatile memory. In order to use the proper calibration data when the CAL FACTOR GHz function is selected, the microprocessor must be advised as to which sensor is being used. The SELECT SENS key is used in conjunction with the numerical keys for this purpose. The sensor number is shown on the barrel of each sensor.

Example: To specify sensor number two:

PRESS	DISPLAY
2	0002
SELECT SENS	

2. The basic instrument contains only one measurement channel. This measurement channel is designated Channel 1, and the front-panel SENSOR connector provides the input to this channel. An option is available for addition of a second measurement channel. When this option is included, the additional channel is designated Channel 2, and input power levels are applied to this channel for measurement through a rear-panel connector. To further enhance the use of the instrument, a Channel 3 operation may be exercised. When Channel 3 operation is specified, Channel 1 and Channel 2 levels are measured and compared by the microprocessor, and the difference in relative dB (with the Channel 2 level as the reference) is displayed. Channel 1 measurements, Channel 2 measurements, or the Channel 3 function can be selected using the numerical keys and the SELECT CHNL key.

Example: to select the Channel 1 input for measurement:

PRESS	DISPLAY
1	0001
SELECT CHNL	

h. dB REF LEVEL Selection. The instrument normally uses 1 mW, 50 ohms as a reference for computing dBm measurement values; the dBm annunciator is lit during such operation. The dB REF LEVEL dB key, used in conjunction with the numerical keys, enables the operator to select any other desired dB reference level; subsequent level indications are with respect to the selected reference, and this display mode is indicated by lighting of the dBr annunciator.

1. A dB reference level is entered by keying in the desired numerical value in dB, using the numerical keys, and then pressing the dB key.

Example: to enter a dB reference level of -15.3 dB:

PRESS	DISPLAY	ANNUNCIATORS dBm	dBr
1	0001	Lighted	Off
5	0015	Lighted	Off
.	0015.	Lighted	Off
3	015.3	Lighted	Off
CHS	-015.3	Lighted	Off
dB REF LEVEL dB		Off	Lighted

2. To return to the dBm measurement display mode, enter a 0 dB reference level.

Example:

PRESS	DISPLAY	ANNUNCIATORS dBm	dBr
0	0000	Off	Lighted
dB REF LEVEL dB		Lighted	Off

NOTE: The maximum display capability of the LED display is ± 99.99 dB. When operating in the dBr mode, keep this fact in mind. Avoid choice of dB reference levels that will result in display values that exceed the LED display capacity. Keyboard entries that are beyond the capability of the instrument produce an error condition.

cc01 = keyboard entry too small
cc02 = keyboard entry too large

2.18 Zeroing the Instrument. For greatest accuracy, especially on the most sensitive ranges, the instrument must be zeroed. To eliminate the need for tedious and often inaccurate manual zeroing, the instrument incorporates an automatic zeroing capability. When automatic zeroing is initiated, the microprocessor reads, averages, and stores zero corrections for each measurement range of the instrument, and applies the proper zero correction for the range in use for all subsequent measurements. Zero corrections are most important on the most sensitive ranges of the instrument. During instrument warmup periods and use in environments with varying ambient temperatures, the instrument should be zeroed frequently if measurements are being 4200 TEMP.

made on the lowest ranges. To zero the instrument, proceed as follows:

CAUTION: Never press the ZERO key with a signal applied to the sensor; to do so will result in large, erroneous zero corrections and grossly inaccurate subsequent measurements.

a. Remove all input power to the sensor.

NOTE: If the instrument is subjected to strong noise fields, shield the sensor in accordance with the instructions in Paragraph 2.27.

b. Press the ZERO key. The zeroing cycle takes approximately 35 seconds while the microprocessor is computing and storing required zero corrections. When the ZERO key is pressed, a logic level signal is activated at rear-panel connector J3; this signal can be used to initiate turn-off of the device to which the instrument sensor is connected, if such operation is desired.

c. When the front-panel unit displays -cc03, zeroing has been completed and the instrument is ready for power level measurements.

2.19 Calibrating the Instrument. The instrument incorporates a calibrator and automatic calibration facilities for fine sensitivity corrections. Sensitivity corrections are limited to a maximum of approximately ± 3% from the original, factory set values as a precautionary measure. This feature protects against gross miscalibration which might occur if calibration were attempted with a power level other than that supplied by the calibrator applied to the sensor. If computed calibration corrections exceed approximately ± 3% from factory set value, the instrument rejects the sensitivity correction and reverts to its previous sensitivity. To use the calibration function, proceed as follows:

a. Set the POWER REF ON switch to the ON position. Allow a stabilization period of approximately 30 seconds.

b. Program the instrument for power mode, autorange, and the appropriate measurement channel.

c. Enter a calibration factor of 0 dB through the keyboard.

d. Connect the sensor to the POWER REF connector.

e. Press the CAL key. The LED display should indicate 1.000 mW ± 1.2%.

f. Set the POWER REF ON switch to the OFF (down) position, and disconnect the sensor from the POWER REF connector.

2.20 Making Power Measurements. Once the instrument has been programmed, calibrated, and zeroed, it is ready for power level measurements. Merely connect the sensor to the source whose power level is to be measured. The power level will be displayed directly on the LED display.

2.21 APPLICATION NOTES.

2.22 Low-Level Measurements. The instrument will provide reliable, reproducible measurements of CW, AM, and FM power levels as low as 1 nW (-60 dBm). It can also be used for pulse measurements but with slightly decreased accuracy (± 1 dB). Peak power levels for pulse measurements should not exceed 200 µW (20 µW for 4200-4 sensors); above this level the sensor enters the region where it operates as a peak detector, and accuracy at such signal levels can be guaranteed for CW and FM only.

2.23 High-Level Measurements. Zeroing of the instrument is not critical when making high-level measurements (10 µW to 100 mW). CW and FM power measurements can be obtained within the specified accuracy up to 100 mW; accuracy cannot be guaranteed for pulse power measurements with peaks exceeding 200 µW.

2.24 High-Frequency Measurements. At frequencies above 1 GHz, the appropriate sensor calibration factor must be entered through the keyboard if the specified accuracy of the instrument is to be realized. (Refer to Paragraph 2.18.f.)

NOTE: Model 4200-4A, 4200-4B, 4200-4E, 4200-5B, and 4200-5E sensors are calibrated for use with a 50-ohm source; Model 4200-4C sensors are calibrated for use with a 75-ohm source. Large deviations from the applicable source impedance may result in serious errors from mismatch and increased VSWR. This effect can be reduced by inserting a low-VSWR attenuator (VSWR less than 1.10) or a low-loss tuner between the source and the sensor.

2.25 Temperature Effects. Specified instrument accuracies apply over an ambient temperature range of 18°C to 30°C. Operation outside this temperature range is possible, but some inaccuracy can be expected. Figure 2-4 shows typical temperature characteristics of a Model 4200 series sensor, and Figure 2-5 shows typical temperature characteristics of the instrument and sensor combined.

NOTE: For best zero stability of the instrument, allow the instrument and sensor to reach a stable temperature.

2.26 VSWR Measurements. The high upper-frequency limit and sensitivity of the instrument facilitate VSWR measurements with a slotted line. VSWR measurements require only comparative, rather than absolute, measurement values; therefore, the instrument may be used up to 20 GHz with a Model 4200-4E sensor. The front-panel meter is especially useful for rapid determination of maximum and minimum power points. VSWR is determined by measuring the dB difference between a maximum and a minimum power point on a slotted line and converting this difference to VSWR. An adapter, usually available from the slotted-line manufacturer, is required to couple the sensor to the slotted line. To make slotted-line VSWR measurements, proceed as follows:

a. Connect the sensor to the sliding carriage, using a suitable adapter.

b. Ascertain that the power source is turned off; then, zero the instrument.

c. Turn on the signal source and slide the carriage along the slotted line until a maximum power point is located. Adjust the source signal level and the probe setting for the least coupling that yields a -41 dBm reading at the maximum power point. (The incident power should be at least 0 dBm.)

d. Slide the carriage along the slotted line until a minimum power point is located. Read the power level at this point. Subtract the measured power level at the minimum power point from that at the maximum power point, ignoring signs. Convert the resultant Δ dB into VSWR, either through use of the VSWR conversion chart (Figure 2-6) or by computation. VSWR is the antilog, base 10, of Δ dB.

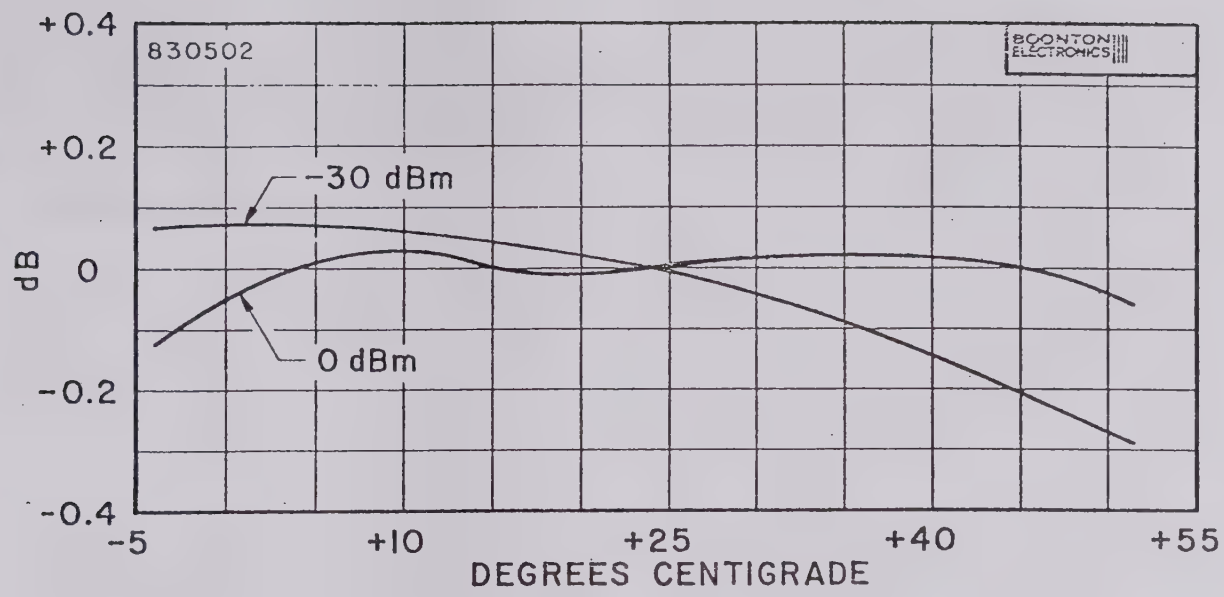

FIGURE 2-4. TYPICAL TEMPERATURE CHARACTERISTICS OF MODEL 4200 SERIES SENSORS

FIGURE 2-5. TYPICAL COMBINED TEMPERATURE CHARACTERISTICS OF INSTRUMENT AND SENSOR 4200 TEMP.

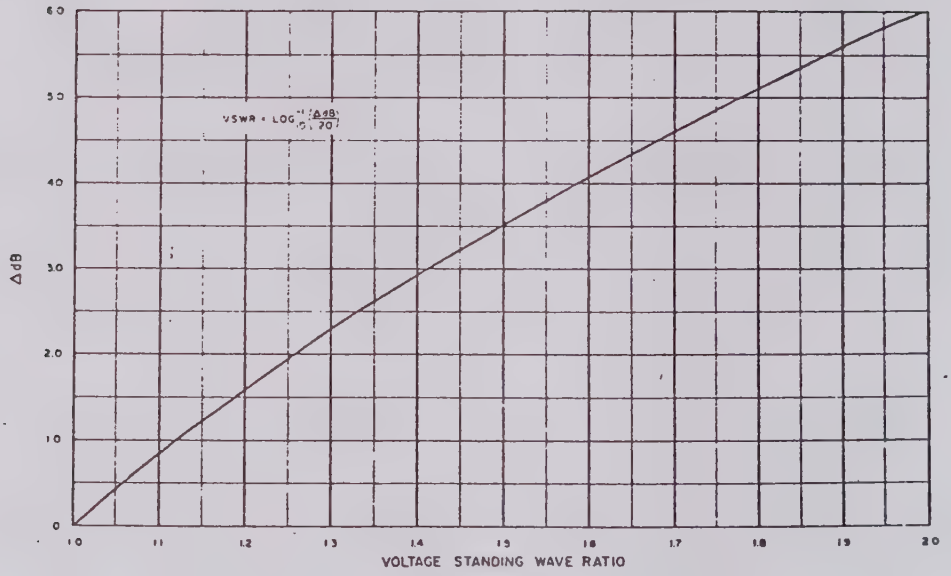

FIGURE 2-6. dB-VSWR CONVERSION CHART

4200 TEMP.

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2.27 Shielding Recommendations. If the instrument is subjected to strong noise fields, accurate zeroing may be difficult unless the sensor is shielded during the zeroing operation. The simplest method of shielding is to connect the sensor to the device whose power level is to be measured, first making sure that the device is turned off; however, in some instances, the device may act as an antenna and introduce additional noise voltage into the sensor. If this happens, disconnect the sensor from the device, stand the sensor, end down, on a copper plate, and hold it down firmly so that the rim of the sensor connector makes good contact with the copper plate at all points. Alternately, wrap a piece of thin copper foil around the body of the connector and crimp the foil around the open end of the connector, making certain that the center pin of the connector is not shorted. If frequent zeroing in strong noise fields is necessary, construct an adapter, using a Type N connector permanently fitted with a copper foil shield.

2.2.8 Analog Output. When the instrument is operated in the power mode, a dc voltage directly proportional to measured power levels is available at rear-panel connector J20 for application to a recorder. This voltage is positive with respect to chassis ground, is linear with power levels, and has a maximum value of 10 volts on each range of the instrument. If the instrument is in the dB mode, the dc output is linear in dB over the entire range of the instrument with 8 V equivalent to 0 dBm and with a sensitivity of 1 V per 10 dB.

2.29 MINIMUM PERFORMANCE STANDARDS.

2.30 Test Equipment Required. For minimum performance testing of the instrument, an adjustable power source, such as the Boonton Electronics Corporation Model 25A Power Meter Calibrator, and a dc voltmeter or oscilloscope capable of measuring 0 to +10 volts are required.

2.31 Preliminary Setup.

a. Turn on the instrument and the adjustable power source and allow sufficient warmup time. If either unit has been stored at ambient temperatures substantially different from the ambient temperature at the minimum performance test facility, make sure enough time is allowed for each device to reach ambient temperature.

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b. Set the adjustable power source output to zero, and connect the sensor between the adjustable power source and the front-panel SENSOR connector of the instrument, using the sensor cable.

c. Key in the following measurement parameter data through the keyboard:

MODE dB
RANGE AUTO
LIMITS dB - any
0 CAL FACTOR dB
N SELECT SENS (N = number of sensor being used)
0 dB REF LEVEL dB
1 SELECT CHNL

NOTE: Maintain the same measurement parameters for each of the following tests unless specifically directed otherwise.

2.33 Automatic Zero Function Test. To check the automatic zeroing function of the instrument, proceed as follows:

a. Ascertain that the signal input to the sensor is zero.

NOTE: Do not confuse 0 dB with zero input. For zero input to the sensor, turn off the adjustable power source.

b. Press the ZERO key and ascertain that all of the following results are obtained.

1. The logic signal level at Pin 3 of the rear-panel connector P3 should switch from a logic low to a logic high when the ZERO key is pressed; it should remain high throughout the zeroing period; it should return to a logic low at the end of the zeroing period.

2. The front-panel display should give the following:

cccc	Settling Period
0000	
0001	
0002	
0003	
0004	
0005	
0006	
cc03	Zeroing Complete

Error Message 03 = Signal Low Out of Range

2.34 Autoranging Mode Test. To check the autoranging function of the instrument, set the output level of the adjustable power source to each of the values listed below and ascertain that the instrument LED display readout agrees with the input power level within ± 0.05 dB ± 1 digit.

+10 dBm ± 0.05 dB
0 dBm ± 0.05 dB
-10 dBm ± 0.05 dB
-20 dBm ± 0.05 dB
-30 dBm ± 0.05 dB
-40 dBm ± 0.05 dB
-50 dBm ± 0.05 dB

2.35 Range Hold Function Test. To check the range hold function of the instrument, proceed as follows:

a. Set the output level of the adjustable power source to 0 dBm.

b. Press the RANGE HOLD key and the MODE PWR key.

c. Ascertain that the LED display readout is 1.000 mW ± 1.2%.

d. Set the adjustable power source output to each of the following levels in succession, and ascertain that the corresponding listed LED indications are obtained on the instrument:

POWER SOURCE LEVEL	INSTRUMENT INDICATION
10 mW	cc04
1 mW	1.000 mW
100 µW	0.100 mW
10 µW	0.010 mW
	or
	cc03 (if less than 10 counts)

NOTE: When the range hold function is selected, input power levels greater than the power decade operative when the selection was made will result in overranging of the instrument and display of an error indication; lower input levels result in a decrease in the number of significant digits in the display. Note that the decimal point and annunciator remain fixed in the hold on range mode.

2.36 Basic Instrument Accuracy Test. To check the basic accuracy of the instrument, proceed as follows:

a. With zero input to the sensor (adjustable power source turned off), zero the instrument by pressing the ZERO key.

b. Upon completion of zeroing, press the MODE dB key.

c. Set the output level of the adjustable power source to each of the following values in succession, and ascertain that the LED display readout agrees with the following:

-50 dBm ± 0.1 dB	-2 dBm ± 0.06 dB
-40 dBm ± 0.05 dB	-3 dBm ± 0.065 dB
-30 dBm ± 0.05 dB	-4 dBm ± 0.07 dB
-20 dBm ± 0.05 dB	-5 dBm ± 0.075 dB
-10 dBm ± 0.05 dB	-6 dBm ± 0.08 dB
0 dBm ± 0.05 dB	-7 dBm ± 0.085 dB
+10 dBm ± 0.05 dB	-8 dBm ± 0.09 dB
- 1 dBm ± 0.055 dB	-9 dBm ± 0.095 dB

NOTE: If the dBm indications are within limits, it may be assumed that power mode indications are also within limits; dBm indications are computed from power measurements within the instrument.

2.37 Power Mode Check. To check operation of the instrument in the power measurement mode, proceed as follows:

a. Without disturbing any measurement parameters used in preceding Paragraph 2.36, adjust the output level of the adjustable power source to 0 dBm and ascertain that the LED display of the instrument indicates 0 dBm ± 0.05 dB.

b. Press the MODE PWR key. The LED display should indicate 1.00 mW ± 1.3%.

c. If desired, other power levels may be checked in similar fashion. To determine the proper power indication for a specific dBm input level, use the formula:

$$P = \log^{-1} dB/10$$

2.38 Calibration Test. To check the automatic calibration capability of the instrument proceed as follows:

a. Set the power source to 1.0 mW.

b. Select PWR MODE, AUTO RANGE.

c. Clear CAL FACTOR by entering 0 dB.

d. Note the display indication; if it is not 1.000 mW, depress the CAL key and note that the indication is now 1.000 mW ± 0.1% ± 1 count. If exactly 1.000 mW, temporarily introduce a CAL FACTOR of 0.05 dB; this will cause the indication to increase to approximately 1.01 mW; depress the CAL key and note that the indication goes to 1.000 mW ± 0.1% ± 1 count; enter 0 dB CAL FACTOR and depress the CAL button to restore the original indication.

2.39 Sensor Selection Check. Entry of the correct number for the sensor in use is absolutely essential for instrument accuracy. Data for each sensor supplied with the instrument has been entered and stored in non-volatile memory at the factory. Stored data consists of functions peculiar to each sensor, such as sensitivity, calibration factors, etc. A direct, absolute check of the sensor data is not possible; however, the basic instrument accuracy test (Paragraph 2.36) and the calibration test (Paragraph 2.38) provide a good indication of satisfactory operation of the sensor selection function. Deliberate entry of an incorrect sensor number will probably result in degradation of basic accuracy. Sensor serial numbers can be recalled from the non-volatile memory by keying in "decimal point" followed by SENS.

2.49 dB Reference Level Function Test. To check the dB reference level function of the instrument, proceed as follows:

a. Set the output power level of the adjustable power source to 0 dBm.

b. Press the MODE dB key and ascertain that the LED display indicates 0 dBm ± 0.05 dB.

c. Enter a -10 dB reference level by pressing the following keys:

1
0
CHS
dB REF LEVEL dB

d. Ascertain that the LED display now indicates +10 dBr ± 0.05 dB. The dBm annunciator should be off, and the dBr annunciator should be lit.

e. Reset the instrument to indicate dBm by pressing the following keys:

0
dB (REF LEVEL dB)

f. Ascertain that the LED display again indicates 0 dBm ± 0.05 dB. The dBm annunciator should be lit, and the dBr annunciator should be off.

2.41 dB Limit Test. To check operation of the dB limit circuits, proceed as follows:

a. Set the output level of the adjustable power source to 0 dBm.

b. Enter a +1 dB high limit by pressing the following keys:

1
LIMITS dB HI

c. Enter a -1 dB low limit by pressing the following keys:

1
CHS
LIMITS dB LO

d. Ascertain that the HI and LO annunciators are both off.

e. Set the output level of the adjustable power source to -2.0 dBm. The LO annunciator should light, and the HI annunciator should remain off. The logic level at Pin 5 of the rear-panel connector P3 should be high; the logic level at Pin 4 of connector P3 should be low.

f. Set the output level of the adjustable power source to +2.0 dBm. The HI annunciator should light, and the LO annunciator should be off. The logic level at Pin 4 of the rear-panel connector P3 should be high; the logic level at Pin 5 of connector P3 should be low.

NOTE: Limits can be entered only in terms of dB, not power; however, the limit function operates in either the dB mode or the PWR mode.

2.42 Calibration Factor Test. To check operation of the calibration factor function, proceed as follows:

a. Set the output level of the adjustable power source to 0 dBm.

b. Press the MODE dB key and note the indication on the LED display.

c. Enter a 0.7 dB calibration factor by pressing the following keys:

0

.

7

CAL FACTOR dB

d. Ascertain that the indication on the LED display is equal to the value noted in Step b plus 0.7 dB

e. Enter a 2 GHz calibration factor by pressing the following keys:

2

CAL FACTOR GHz

f. Determine the calibration correction for 2 GHz from the chart on the barrel of the sensor. Ascertain that the LED display indicates the value noted in Step b plus the calibration factor read from the chart.

NOTE: For proper calibration factor correction and instrument accuracy, it is essential that the sensor number entered into the instrument prior to measurement agrees with the number indicated on the barrel of the sensor used for the measurement. Calibration factors that are invoked are operative in both the dB mode and the PWR mode.

SECTION III

IEEE-488 INTERFACE OPERATING INSTRUCTIONS

3.1 INTRODUCTION

The IEEE-488 (GPIB) Interface option permits external control and data capture by a wide variety of compatible controllers. The instrument may be operated with other GPIB compatible devices to achieve specific test automation goals. Such test systems require no specialized control interfaces for proper electrical operation. The overwhelming popularity of the GPIB concept is largely due to this fact.

Software problems have been more troublesome. There is no standard for data formats on the GPIB. Both instruments and controllers vary widely in their ability to create and/or respond to specific numeric formats and delimiters (end of message markers). Certain controllers and instrument combinations cannot work together due to format/delimiter conflicts. The higher level controllers (high-end calculators and minicomputers) generally provide a great deal of flexibility in formatting input and output data. At the other end of the spectrum are certain test system GPIB interfaces and small microcomputers. These devices are much more stringent regarding input and output formats.

Fortunately, this problem is being addressed. Although a standard has not yet been written, certain common practices are achieving de facto standard status. These practices have been adhered to in designing the 4200 GPIB interface formats and delimiters. This assures the user of format compatibility with almost all controllers, including the least expensive.

3.2 CAPABILITY

Certain sub-sets of full GPIB function are specified in the IEEE-488 standard. The 4200 includes the following capabilities:

SH1 Source Handshake

AH1	Acceptor Handshake
T8	Basic Talker, Unaddress if MLA. No Serial Poll or Talk Only capability
L4	Basic Listener, Unaddress if MTA
SR0	No Service Request capability
RL2	Remote-Local capability except LLO
PP0	No Parallel Poll capability
DC0	No Device Clear capability
DT0	No Device Trigger capability

NOTE: MLA = My Listen Address
MTA = My Talk Address
LLO = Local Lockout

3.3 OPERATION

The discussion which follows assumes the user is acquainted with GPIB principles and terminology. Please refer to the controller instruction book for the syntax needed to create specific bus commands and addressing sequences. Examples will be given for the HP 9825 calculator.

The 4200, whether in local or remote control, operates in two separate states. The first is the measuring state, during which the instrument performs and displays measurements. The other is the entry/recall state, operative during number entry or after recalling stored information.

NOTE: When operating on the bus, it is important to remember that the 4200 can only send that information which appears on the front panel display.

3.3.1 Measurement Mode Functions

These functions change the measurement mode.

Keyname	GPIB	Function
PWR MODE	P	Display Measured Power
dB Mode	B	Display Measured dBm or dBrel

3.3.1 Measurement Mode Functions (Continued)

Keyname	GPIB	Function
AUTO	A	Set Autorange mode
HOLD	O	Set Range Hold mode

3.3.2 Data Store/Recall Functions

These functions enable the storage or retrieval of numeric constants used by the instrument. Operation reverts to the measuring state after data storage.

Keyname	GPIB	Function
LO LIMIT	L	Low limit value, in dB
HI LIMIT	H	High limit value, in dB
dB CALFACTOR	D	Calfactor constant, in dB
GHz	F	Interpolate Freq./Calfactor Table
SENS	S	Select Sensor Data Tables
CHNL	N	Select Channel Number
dB REF	R	dB Reference Level for dB Mode

3.3.3 Special Functions

These include the Auto-zero, Auto-calibrate, and Clear functions.

Keyname	GPIB	Function
ZERO	Z	Initiates an auto-zero cycle
CAL	K	Performs 1 mW auto-calibration
CLEAR	C	Clear numeric entry to zero

3.3.4 IEEE-488 Bus Command Extensions

The following functions are added to Bus operation:

Name	GPIB	Function
ADR. ZERO	Y	Zero selected ranges (0-6)
SET RANGE	G	Set to selected range (0-6)

These commands must be preceded by an appropriate argument. The argument for "G" is the range number (0 = 10 nW to 6 = 10 mW for 4200-4 Sensors) to be set.

To implement Y command:

Argument for Y must contain span of ranges to be zeroed; i.e., sending "02Y" will zero ranges 0 through 2. If only one range is to be zeroed, then argument must begin and end with the same code. Sending "11Y" will zero only R1.

Timing:

From execution of command to measurement mode, the maximum time is as follows:

00Y	9.7 secs.
01Y	13.4 "
02Y	14.6 "
03Y	15.1 "
04Y	15.4 "
05Y	15.6 "
06Y	15.7 "

3.3.5 Remote Programming of the 4200

The bus programming syntax closely mirrors the front panel keystroke sequence. Each key has been assigned an alphanumeric character, and sending that character is equivalent to depressing that front panel key. The resultant operation is indistinguishable from local control.

Numeric values are translated by the GPIB interface, however, so that commonly observed formats will be acceptable. Both fixed point and floating point formats

may be used. These representations are converted to their equivalent fixed point values, and the sign information is post-fixed automatically. This insures that natural notations for numbers will be accepted by the 4200.

Suppose we wish the instrument in the PWR mode. The 9825 could be programmed:

```
wrt 716,"P"
```

The "wrt" instructs the 9825 to send data on the bus to one or more listeners. The number following is the address information: 7 = the calculator address, 16 = the 4200 address (all examples will use this address, although it is user settable to any valid address). When the 9825 interprets the first part of the line, it will assert the ATN line to signify that commands or addresses will be sent on the bus. Following that it will send three bytes or characters: Unlisten, the 9825 Talk Address, and the 4200 Listen Address. This will configure both the calculator and the instrument for the data transfer. After the last command byte has been accepted, ATN will be released to the false state by the 9825. All information on the bus is interpreted as data in this mode. While in the data mode, the calculator will send the character "P" to the instrument. There it will be interpreted as equivalent to depressing the PWR Mode key, and that function will be executed. Since there is no more data to be sent, the 9825 will send a delimiter, the ASCII codes for Carriage Return and Line Feed. The 4200 recognizes the Line Feed as an end of message signal and returns to the bus idle condition.

This lengthy discussion of sending a single programming byte serves to illustrate two important points: every data transfer is preceded by a command/address preamble, and each transfer is terminated by a line feed character. In the immediate example, six characters have been sent on the bus: only one was a programming byte.

The Measurement Mode functions (P,B,A,O) and the Special functions (Z,K) do not expect any numeric value. They all execute as received. The following will program dB and Auto-range mode, for example:

```
wrt 716,"BA"
```

or just as well:

```
wrt 716,"AB"
```

Note that the sequence is unimportant, except to observe that each function executes in the order received on the bus. Suppose the 4200 is to be auto-zeroed, and then asked to send the reading in Power and Auto-range mode. We might instruct the 9825 as follows:

```
wrt 716,"APZ"
wait 20000
wait 20000
red 716,V,S
```

The Auto-zero cycle time is about 40 seconds. Until this time is completed, the 4200 will be unable to respond with new data. The first line above sets the operating mode and initiates the zero cycle. The next two lines delay the program about 40 seconds, and the last line reads the response from the instrument. This consists of two numeric values: the first being the front panel reading and the second a status value which is normally zero. These two numbers will be stored in the calculator variables (storage locations) V and S. Note that each data transmission from the 4200 will send two values. When the status value is non-zero, indicating an error condition, the data value will be set to zero. The program will normally test the status value to assure valid operating conditions.

The general syntax for the Store/Recall functions is the same as the front panel sequence: if a numeric value immediately precedes the function, that value will be stored; otherwise, the existing stored value will be recalled to the front panel. Thus these functions (L,H,D,F,S,N,R) operate in a dual mode. To illustrate, suppose it is desired to store the current power level in dBm into the dB Reference so that all future readings will be referenced to the current value. Allowance must be made for the possibility that the current reading is a dB relative value. To do this, we must read the current dB value, recall the existing dB reference, compute the true dBm value, and store this value into dB Reference:

```
red 716,V,S
wrt 716,"R"
red 716,X,S
V+X → Y
wrt 716,Y,"R"
```

Note that R is used twice in the program: the first time to get the existing value for dB Reference, and the second time to store the computed value. Also note that the two read statements ("red") each fetch a different value: the first one is the power value in dB, and the second the dB Reference.

3.3.7 Output Data Format

The data output by the 4200 consists of a string containing Power Measurement Mode, Channel in use, Front Panel display, Status of Measurement, and the Range Code. The following format is used:

abcsddddEsd,S,R(cr)(lf)

where

ab = Power Measurement Mode, coded as follows:

- PW = Power in watts
- DM = dBm Mode
- DR = dB Reference to other than 50 Ω

c = Channel Number, coded as follows:

- A = Channel 1
- B = Channel 2
- C = Channel 3

s = Sign

d = Digit 0 through 9

E = Exponent Marker

, = Data Delimiter

S = Status Bit, coded as follows:

0 = No Error

1 = Entry Too Small

2 = Entry Too Large

3 = Measurement Underrange

4 = Measurement Overrange

7 = Channel 3 Out of Range

R = Range Code, coded as follows:

0 = -50 dBm or 10 nW

1 = -40 dBm or 100 nW

2 = -30 dBm or 1 μW

3 = -20 dBm or 10 μW

4 = -10 dBm or 100 μW

5 = 0 dBm or 1 mW

6 = +10 dBm or 10 mW

7 = +20 dBm or 100 mW

3.3.8 Setting the 4200 GPIB Address

Prior to using the 4200 on the GPIB, it must be assigned a unique address. This address is set using the rear panel address switch (S1). The five rightmost switches are set for the desired address according to the following table:

Decimal Address	Talk Code	Listen Code	Switch Setting S5	S4	S3	S2	S1
0	@	SP	0	0	0	0	0
1	A	!	0	0	0	0	1
2	B	"	0	0	0	1	0
3	C	#	0	0	0	1	1
4	D	$	0	0	1	0	0
5	E	%	0	0	1	0	1
6	F	&	0	0	1	1	0
7	G	'	0	0	1	1	1
8	H	(	0	1	0	0	0
9	I	)	0	1	0	0	1
10	J	*	0	1	0	1	0

Decimal Address	Talk Code	Listen Code	Switch Setting S5	S4	S3	S2	S1
11	K	+	0	1	0	1	1
12	L	,	0	1	1	0	0
13	M	-	0	1	1	0	1
14	N	.	0	1	1	1	0
15	O	/	0	1	1	1	1
16	P	0	1	0	0	0	0
17	Q	1	1	0	0	0	1
18	R	2	1	0	0	1	0
19	S	3	1	0	0	1	1
20	T	4	1	0	1	0	0
21	U	5	1	0	1	0	1
22	V	6	1	0	1	1	0
23	W	7	1	0	1	1	1
24	X	8	1	1	0	0	0
25	Y	9	1	1	0	0	1
26	Z	:	1	1	0	1	0
27	[	;	1	1	0	1	1
28	\	<	1	1	1	0	0
29	]	=	1	1	1	0	1
30	^	>	1	1	1	1	0

NOTE: Address 31 (11111) will not be recognized and should not be used.

3.3.9 Talk Only Mode

This mode is used to communicate with an output device such as a printer without using a controller. When the TALK ONLY switch is placed in the 1 position, the 4200 will automatically send the result of each measurement over the bus. The receiving device must be configured to operate in this mode.

3.3.10 Listen Only Mode

Similarly, if the LISTEN ONLY switch is placed in the 1 position, the 4200 will be a listener for all data mode transmission. This function is included primarily for troubleshooting interface and programming problems; it has little utility in normal operation.

3.3.11 Command Response

In addition to the Talk and Listen Address commands, the 4200 responds to the following:

Addressed Commands: Responds if Listen Addressed

GTL	Go To Local	Enables Panel Control
GET	Group Trigger	Hold Current Measurement

Listen Address Group

UNL	Unlisten	De-address as listener

Talk Address Group

UNT	Untalk	De-address as talker

Unencoded Commands

IFC	Interface Clear	Initialize Interface
REN	Remote Enable	Permits remote operation

3.4 APPLICATIONS

3.4.1 Insertion Loss or Gain, with Option -03

Channel 2 measures incident power, and Channel 1 measures output power. The program will request reference conditions, and wait for the user to set them up.

Following establishment of the reference, the program will loop on insertion loss/gain measurements. Each measurement is triggered by the user. Zeroing is prompted in the local mode at the beginning of the program.

Program variable usage:

P : = power measurement value
S : = status value
Z : = dummy input for prompts
R : = range value

PROGRAM STATEMENTS	COMMENTS
0: cli 7	clear interface
1: ent "zero ch1,2",Z	prompt for zeroing
2: rem 7	enable remote
3: wrt 716,"1NA0R2NA0R3N"	0 dB ref, auto - set ch3
4: ent "ref measure",Z	prompt to set up ref
5: red 716,P,S ,R	read ref value, status
6: if S 0;dsp "error",S;beep;gto 4	test status
7: wrt 716,"1N",P,"R3N"	set ch1 dBref = P
8: beep;ent "measure",Z	prompt for measurement
9: red 716,P,S,R	read measurement, status
10: if S 0;dsp "error",S;beep;wait 100;gto8	test status
11: prt P," dB";gto 8	print measurement
12: end	

Reading errors, should they occur, will be signalled by a double beep from the calculator; normal measurements will give a single beep. There will be one print line per measurement. The reference value is not printed in this example.

The above program also measures reflection coefficient if Channel 1 measures reflected power and Channel 2 incident power. The reference conditions are established with a short at the test port of the directional coupler.

TABLE OF REPLACEABLE PARTS

Reference	Description			BEC Part No.
		FRAME ASSEMBLY (A1)		
J26	Connector		Amphenol 80-PC-2FT	479119
S1	Switch, Toggle	D.P.D.T.	CK 7203-S-P-Y-Z-Q	465222
S2	Switch, Toggle	3.P.D.T.	CK 7301-S-P-Y-Z-Q	465223
		REAR PANEL ASSEMBLY		
F1	Fuse, Slo-Blo	0.3 A 120 V	Buss MDL 3/10	545507
F1	Fuse, Slo-Blo	0.2 A 240 V	Bus MDL 2/10	545508
J20	Receptacle, BNC		Dage 081-1	479123
T1	Transformer, Power		Boonton Electronics	446086
		DISPLAY PC BOARD ASSEMBLY		
A1	Op. Amp	CA3140AE	RCA	535050
C1	Capacitor, Cer.	33 pF 5% 1 kV	Sprague C030B102G330J	224139
C2	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C3	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C4	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C5	Capacitor, Cer.	1000 pF 10% 1 kV	Sprague 10TS-D10	224310
CR1 through CR13	Diode, LED	IT/F-536024	H.P.	536022
IC1	Integrated Circuit	MM74C48N	National Semiconductor	534214
IC2	Integrated Circuit	CD4051BE	RCA	534139
IC3	Integrated Circuit	CD4049AF	RCA	534172
IC4	Resistor Network	100 Ω 2% 1.8 W	AB316B101	345021
IC5	Resistor Network	4.7 kΩ 2% 1.8 W	AB316B472	345020
IC6	Numeric Display	HP5082-7653	H.P.	536809
IC7	Integrated Circuit	DS8863N	National Semiconductor	534215
IC8	Numeric Display	HP5082-7653	H.P.	536809
IC9	Numeric Display	HP5082-7653	H.P.	536809
IC10	Numeric Display	HP5082-7653	H.P.	536809
IC11	Numeric Display	HP5082-7656	H.P.	536810
M1	Meter	OMS-DMA001-CD	Modutec	554332
Q1	Transistor, NPN	2N5088	Motorola	528047
R1	Resistor, MF	93.1 kΩ 1%	RN55	341493
R2	Resistor, Comp.	91 kΩ 5%	AB-EB	343492
R3	Resistor, MF	1.0 MΩ 1%	RN55	341600
R4	Resistor, MF	9.09 kΩ 1%	RN55	341392
R5	Resistor, MF	8.87 kΩ 1%	RN55	341391
R6	Resistor, Comp.	15 kΩ 5%	AB-EB	343417

Reference	Description			BEC Part No
		DISPLAY PC BOARD ASSEMBLY (CONTINUED)		
R7	Resistor, Comp.	4.7 kΩ 5%	AB-EB	343365
R8	Resistor, Var.	10 kΩ 10% 0.5 W	Beckman 72XWR10K	311348
S1 through S26	Switch, Pushbutton	TL360	Grisby	465228
		CALIBRATOR ASSEMBLY		
C6	Capacitor, Feedthru	1000 pF	Erie 2499-003 (Modified)	227122
J2	Receptacle, Type N		Amphenol 82-368-1050	479219
S1	Switch, Toggle	S.P.D.T.	Alco MST-105D	465226
		CALIBRATOR PC BOARD ASSEMBLY		
A1	Op. Amp.	LM301AN	National Semiconductor	535012
C1	Capacitor, Cer.	470 pF 10% 500 V	RMC-JG	224219
C2	Capacitor, Mica	100 pF 5% 300 V	DM5-FC101J	205006
C3	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C4	Capacitor, Var.	3.5 - 18 pF	Johanson #9373	281011
C5	Capacitor, Cer.	1000 pF 10% 1 kV	Sprague 10TS-D10	224310
C6	*See Calibrator Assembly*			
C7	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C8	Capacitor, Cer.	0.01 µF 100 V	Erie 805-000X5V0103Z	224119
C9	Capacitor, Mica	36 pF 5% 300 V	DM5-EC360J	205003
C10	Capacitor, Mica	200 pF 5% 100 V	DM5-FA201J	205024
C11	Capacitor, Mica	10 pF 5% 300 V	DM5-CC100J	205002
C12	Capacitor, Var.	3.5 - 18 pF	Johanson #9373	281011
CR1	Diode, Sil.	HSCH-1001	H.P.	530174
CR2	Diode, Sil.	HSCH-1001	H.P.	530174
CR3	Diode, Tuning	MV1650	Motorola	530762
IC1	Voltage Reference	AD581JH	Analog Devices	535053
L1	Choke, RF	4.7 µH 10%	Gowanda 10/471	400384
L2	Choke, RF	0.56 µH 10%	Gowanda 10/560	400382
L3	Coil	0.033 µH	Boonton Electronics	400386
Q1	Transistor, NPN	2N3866	Motorola	528116
R1	Resistor, MF	1.5 kΩ 1%	RN55	341317
R2	Resistor, MF	100 kΩ 1%	RN55	341500
R3	Resistor, MF	100 kΩ 1%	RN55	341500
R4	Resistor, Var.	1 kΩ 10% 0.5 W	Bourns 3299X-1-102	311410
R5	Not Used			
R6	Resistor, Comp.	100 kΩ 5%	AB-EB	343500
R7	Resistor, MF	2.43 kΩ 1%	RN55	341337
R8	Resistor, Comp.	1 kΩ 5%	AB-EB	343300

Reference	Description			BEC Part No.
		CALIBRATOR PC BOARD ASSEMBLY (CONTINUED)		
R9	Resistor, Comp.	1 kΩ 5%	AB-EB	343300
R10	Resistor, MF	10.0 kΩ 1%	RN55	341400
R11	Resistor, MF	5.11 kΩ 1%	RN55	341368
R12	Resistor, Comp.	1.2 kΩ 5%	AB-EB	343308
R13	Resistor, Comp.	1.3 kΩ 5%	AB-EB	343311
R14	Resistor, Comp.	75 Ω 5%	AB-EB	343184
R15	Resistor, MF	50.00 Ω 0.1% 0.25 W	PME55-T2	325916
		CHOPPER PC BOARD ASSEMBLY (A4)		
C1	Capacitor, PP	0.1 µF 10% 100 V	F-Dyne PP11-.1-100-10	234148
C2	Capacitor, PP	0.1 µF 10% 100 V	F-Dyne PP11-.1-100-10	234148
IC1	Integrated Circuit	CD4016BE (Selected)	RCA	534223
R1	Resistor, MF	5.62 MΩ 1% 0.25 W	GE-12	325397
R2	Resistor, MF	5.62 MΩ 1% 0.25 W	GE-12	325397
R3	Resistor, MF	51.1 kΩ 1%	RN55	341468
R4	Resistor, Var.	20 kΩ 10% 0.5 W	Beckman 72PR20K	311354
R5	Resistor, Var	20 kΩ 10% 0.5 W	Beckman 72PR20K	311354
R6	Resistor, MF	51.1 kΩ 1%	RN55	341468
		CONTROL PC BOARD ASSEMBLY (A5)		
BT1	Power Cell	400-5S	Power Conversions Inc.	556005
BT2	Power Cell	400-5S	Power Conversions Inc.	556005
C1	Capacitor, Mica	430 pF 1% 500 V	DM15-431F	200037
C2	Capacitor, Mica	100 pF 5% 500 V	DM15-F101J	200001
C3	Capacitor, Tant	0.47 µF 10% 35 V	Sprague 196D474X9035HA1	283324
C4 through C7	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
CR1	Diode, Sig.	1N914	T.I.	530058
CR2	Diode, LED	IT/F 536024	H.P.	536023
IC1	Integrated Circuit	SN7404N	T.I.	534042
IC2	Resistor Network	4.7 kΩ 2% 1.8 W	AB316B472	345020
IC3	Integrated Circuit	Z80-CPU-PS	Zilog	534159
IC4	Integrated Circuit	SN74LS42N	T.I.	534210
IC5	Integrated Circuit	SN74LS08N	T.I.	534156
IC6	PROM	Programmed	4200-1	534221
IC7	PROM	Programmed	4200-1	534222
IC8	Integrated Circuit	P2114	Intel	534212
IC9	Integrated Circuit	CD4011AE	RCA	534022
IC10	Integrated Circuit	P2114	Intel	534212
IC11	Integrated Circuit	HM3-6501-9	Harris Semiconductor	534213
IC12	Integrated Circuit	HM3-6501-9	Harris Semiconductor	534213
IC13	Resistor Network	4.7 kΩ 2% 1.8 W	AB316B472	345021

Reference	Description			BEC Part No.
	CONTROL PC BOARD ASSEMBLY (A5) (CONTINUED)			
IC14	Integrated Circuit	SN74LS42N	T.I.	534210
IC15	Integrated Circuit	SN74LS32N	T.I.	534168
IC16	Integrated Circuit	AM8255	Advanced Micro Devices	534171
IC17	Resistor Network	4.7 kΩ 2% 1.8 W	AB316B472	345020
IC18	Integrated Circuit	P8279	Intel	534211
L1	Choke, RF	15 µH 10%	Gowanda 10/152	400373
Q1	Transistor, NPN	2N3904	Motorola	528071
R1	Resistor, Comp.	330 Ω 5%	AB-EB	343250
R2	Resistor, Comp.	10 kΩ 5%	AB-EB	343400
R3	Resistor, Comp.	10 kΩ 5%	AB-EB	343400
R4	Resistor, Comp.	4.7 kΩ 5%	AB-EB	343365
R5	Resistor, Comp.	5.1 kΩ 5%	AB-EB	343368
R6	Resistor, MF	100 Ω 1%	RN55	341200
R7	Resistor, Comp.	10 kΩ 5%	AB-EB	343400
S1	Switch, Rocker	(8)SPST	Grayhill 76SB08	465225
	INPUT PC BOARD ASSEMBLY (A6)			
A1	Op. Amp.	LM301AN	National Semiconductor	535012
A2	Op. Amp.	LM311N	National Semiconductor	535034
A3	Op. Amp.	LM301AN	National Semiconductor	535012
A4	Op. Amp.	CA3140AE	RCA	535050
A5	Op. Amp.	LF356H (Selected)	National Semiconductor	535062
A6	Op. Amp.	LF356H (Selected)	National Semiconductor	535062
A7	Op. Amp.	LF356H	National Semiconductor	535052
A8	Op. Amp.	CA3140AE	RCA	535050
A9	Op. Amp.	CA3140AE	RCA	535050
C1	Capacitor, Cer.	33 pF 5% 1 kV	Sprague 10TCC-Q33	224139
C2	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C3	Capacitor, Cer.	33 pF 5% 1 kV	Sprague 10TCC-Q33	224139
C4	Capacitor, PE	0.01 µF 10% 80 V	Sprague 192P1039R8	234092
C5	Capacitor, Cer.	150 pF 10% 1 kV	Sprague 10TS-T15	224314
C6	Capacitor, Cer.	33 pF 5% 1 kV	Sprague 10TCC-Q33	224139
C7	Capacitor, Cer.	33 pF 5% 1 kV	Sprague 10TCC-Q33	224139
C8	Capacitor, Cer.	1000 pF 10% 1 kV	Sprague 10TS-D10	224310
C9	Capacitor, Mica	1500 pF 1% 500 V	Cornell Dubilier CD19FD152F-03	200531
C10	Capacitor, Cer.	0.01 µF 10% 100 V	AVX SR201C103KAA	224269
C11	Capacitor, Cer.	0.01 µF 10% 100 V	AVX SR201C103KAA	224269
C12	Capacitor, Cer.	0.01 µF 100 V	Erie 805-000X5V0103Z	224119
C13	Capacitor, Cer.	68 pF 10% 1 kV	Sprague 10TS-Q68	224312
C14	Capacitor, PE	0.01 µF 10% 80 V	Sprague 192P1039R8	234092
C15	Capacitor, Cer.	0.01 µF 100 V	Erie 805-000X5V0103Z	224119
C16	Capacitor, Cer.	68 pF 10% 1 kV	Sprague 10TS-Q68	224312
C17	Capacitor, Cer.	2200 pF 10% 250 V	Sprague 2SS-D22	224309
C18	Capacitor, PE	0.01 µF 10% 80 V	Sprague 192P1039R8	234092

Reference	Description			BEC Part No.
	INPUT PC BOARD ASSEMBLY (A6) (CONTINUED)			
C19	Capacitor, Cer.	330 pF 10% 1 kV	Sprague 10TS-T33	224313
C20	Capacitor, PP	0.1 µF 10% 100 V	F-Dyne PP11-.1-100-10	234148
C21	NOT USED			
C22	Capacitor, PP	0.1 µF 10% 100 V	F-Dyne PP11-.1-100-10	234148
C23	Capacitor, Cer.	33 pF 5% 1 kV	Sprague 10TCC-Q33	224139
C24	Capacitor, Cer.	1000 pF 10% 1 kV	Sprague 10TS-D10	224310
C25	Capacitor, Cer.	33 pF 5% 1 kV	Sprague 10TCC-Q33	224139
C26	Capacitor, Cer.	1000 pF 10% 1 kV	Sprague 10TS-D10	224310
C27 through C34	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C35	Capacitor, Cer.	150 pF 10% 1 kV	Sprague 10TS-T15	224314
IC1	Integrated Circuit	AM8255	Advanced Micro Devices	534171
IC2	Op. Amp.	AD565JN/BIN	Analog Devices	421034
IC3	Integrated Circuit	CD4053BE	RCA	534207
IC4	Integrated Circuit	CD4051BE	RCA (ONLY)	534209
IC5	Integrated Circuit	CD4047AE	RCA (ONLY)	534229
IC6	Integrated Circuit	CD4051BE	RCA (ONLY)	534209
IC7	Integrated Circuit	CD4013BE	RCA (ONLY)	534205
IC8	Integrated Circuit	CD4013BE	RCA (ONLY)	534205
IC9	Integrated Circuit	CD4016BE	RCA (ONLY)	534218
IC10	Integrated Circuit	CD4016BE	RCA (ONLY)	534218
IC11	Integrated Circuit	CD4075BE	RCA	534206
IC12	Resistor Network	47 kΩ 2% 1.6 W	AB314B473	345019
IC13	Integrated Circuit	CD4051BE	RCA (ONLY)	534209
IC14	Integrated Circuit	CD4051BE	RCA (ONLY)	534209
R1	Resistor, Var.	100 Ω 10% 0.5 W	Beckman 72PR100	311408
R2	Resistor, Comp.	2.7 kΩ 5%	AB-EB	343341
R3	Resistor, Comp.	1 kΩ 5%	AB-EB	343300
R4	Resistor, Comp.	100 Ω 5%	AB-EB	343200
R5	Resistor, MF	10.0 kΩ 1%	RN55	341400
R6	Resistor, MF	5.11 kΩ 1%	RN55	341368
R7	Resistor, MF	9.09 kΩ 1%	RN55	341392
R8	Resistor, MF	1.0 kΩ 1%	RN55	341300
R9	Resistor, MF	10.0 kΩ 1%	RN55	341400
R10	Resistor, Comp.	3 MΩ 5%	AB-EB	343646
R11	Resistor, Var.	50 kΩ 10% 0.5 W	Beckman 72PR50K	311393
R12	Resistor, MF	1.0 MΩ 1%	RN55	341600
R13	Resistor, MF	1.0 MΩ 1%	RN55	341600
R14	Resistor, MF	237 kΩ 1%	RN55	341536
R15	Resistor, MF	249 kΩ 1%	RN55	341538
R16	Resistor, MF	12.1 kΩ 1%	RN55	341408
R17	Resistor, MF	806 kΩ 1%	RN55	341587
R18	Resistor, Comp.	10 MΩ 5%	AB-EB	343700
R19	Resistor, Comp.	10 MΩ 5%	AB-EB	343700
R20	Resistor, MF	1.82 kΩ 1%	RN55	341325
R21	Resistor, MF	20.0 kΩ 1%	RN55	341429
R22	Resistor, MF	221 kΩ 1%	RN55	341533

Reference	Description			BEC Part No.
	INPUT PC BOARD ASSEMBLY (A6) (CONTINUED)			
R23	Resistor, MF	1.0 MΩ 1%	RN55	341600
R24	Resistor, Var.	25 kΩ 10% 0.5 W	Beckman 72PR25K	311400
R25	Resistor, MF	1.0 MΩ 1%	RN55	341600
R26 through R28	Resistor, MF	100.0 kΩ 1%	RN55	341500
R29	Resistor, MF	110 kΩ 1%	RN55	341504
R30	Resistor, MF	100.0 kΩ 1%	RN55	341500
R31	Resistor, MF	110 kΩ 1%	RN55	341504
R32	Resistor, MF	9.09 kΩ 1%	RN55	341392
R33	Resistor, MF	9.09 kΩ 1%	RN55	341392
R34	Resistor, Comp.	10 kΩ 5%	AB-EB	343400
R35	Resistor, Comp.	5.1 kΩ 5%	AB-EB	341368
R36	Resistor, Var.	10 kΩ 10% 0.5 W	Beckman 72PR10K	311328
R37	Resistor, Comp.	3.9 kΩ 5%	AB-EB	343357
R38	Resistor, MF	7.87 kΩ 1%	RN55	341386
R39	Resistor, MF	80.6 kΩ 1%	RN55	341487
R40	Resistor, MF	806 kΩ 1%	RN55	341587
R41	Not Used			
R42	Resistor, Comp.	7.5 kΩ 5%	AB-EB	343384
R43	Resistor, MF	1.0 kΩ 1%	RN55	341300
R44	Resistor, Var.	200 kΩ 10% 0.5 W	Beckman 72PR200K	311401
R45	Resistor, Var.	10 kΩ 10% 0.5 W	Beckman 72PR10K	311328
R46	Not Used			
R47	Resistor, Comp.	3.9 kΩ 5%	AB-EB	343357
R48	Resistor, MF	909 kΩ 1%	RN55	341592
RT1	Thermistor	50 Ω 10%	Fenwal LB15J1	325007
	POWER SUPPLY PC BOARD ASSEMBLY (A7)			
A1	Op. Amp.	LM339N	National Semiconductor	535018
C1	Capacitor, Elec.	4500 µF +75/-10% 25 V	GE 86F537M	283318
C2	Capacitor, Elec.	4500 µF +75/-10% 25 V	GE 86F537M	283318
C3	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C4	Capacitor, Tant.	0.1 µF 20% 35 V	Sprague 196D104X0035HA1	283306
C5	Capacitor, Tant.	1.0 µF 10% 35 V	Sprague 196D105X9035HA1	283216
C6	Capacitor, PE	0.015 µF 10% 80 V	Sprague 192P1539R8	234094
C7	Not Used			
C8	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C9	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C10	Capacitor, Elec.	330 µF +50/-10% w5 V	Sprague 530D337F025PE	283330
C11	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C12	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C13	Capacitor, Elec.	1000 µF +50/-10% 10 V	Sprague 530D108F010PE	283329
C14 through C18	Capacitor, Tant.	6.8 µF 10% 35 V	Sprague 196D685X9035KA1	283217
C19	Capacitor, Cer.	22 pF 5% 200 V	Mepco CV15NC220J	224217

Reference	Description			BEC Part No.
	POWER SUPPLY PC BOARD ASSEMBLY (A7) (CONTINUED)			
CR1	Diode, Bridge	VS-248	Varo	532014
CR2	Diode, Sil.	1N4001	Motorola	530151
CR3 through CR7	Diode, Sig.	1N914	T.I.	530058
CR8	Diode, Bridge	VSK-140	Varo	532022
CR9	Diode, Zener	1N5250 (20 V)	Motorola	530115
CR10	Diode, Sil.	1N4001	Motorola	530151
CR11	Diode, Zener	1N5259 (39 V)	Motorola	530085
CR12	Diode, Zener	1N5259 (39 V)	Motorola	530085
CR13 through CR20	Diode, Sil. Bridge	VSK-140	Varo	532022
CR21 through CR24	Diode, Sil.	1N4001	Motorola	530151
CR25	Diode, Sig.	1N914	T.I.	530058
IC1	Voltage Regulator	µA78MGUIC (Modified)	Fairchild	535058
IC2	Integrated Circuit	CD4011AE	RCA	534022
IC3	Voltage Regulator	SG3524N	Silicon General	535054
IC4	Integrated Circuit	CD4073BE	RCA	534216
IC5	Integrated Circuit	CD4013BE	RCA (ONLY)	534205
IC6	Voltage Regulator	µA78MGUIC (Modified)	Fairchild	535058
IC7	Voltage Regulator	µA79MGUIC (Modified)	Fairchild	535057
IC8	Voltage Regulator	µA78GUIC (Modified)	Fairchild	535059
IC9	Voltage Regulator	µA79MGUIC (Modified)	Fairchild	535057
L1	Inductor	400 µH	Boonton Electronics	042176-1
Q1	Transistor, NPN	2N3904	Motorola	528071
Q2	Transistor, PNP	2N3906	Motorola	528076
Q3	Transistor, NPN	MJE-220	Motorola	528125
Q4	Not Used			
Q5	Not Used			
Q6	Transistor, NPN	2N3904	Motorola	528071
Q7	Transistor, PNP	MJE-230	Motorola	528126
Q8	Transistor, NPN	2N3904	Motorola	528071
Q9	Transistor, NPN	2N3904	Motorola	528071
Q10	Transistor, NPN	MJE-220	Motorola	528125
Q11	Transistor, NPN	MJE-220	Motorola	528125
R1 through R3	Resistor, Comp.	51 kΩ 5%	AB-EB	343468
R4	Not Used			
R5	Resistor, Comp.	5.1 MΩ 5%	AB-EB	343668
R6	Resistor, Comp.	5.1 MΩ 5%	AB-EB	343668
R7	Resistor, MF	24.9 kΩ 1%	RN55	341438

Reference	Description			BEC Part No.
	POWER SUPPLY PC BOARD ASSEMBLY (A7) (CONTINUED)			
R8	Resistor, Comp.	10 kΩ 5%	AB-EB	343400
R9	Resistor, MF	84.5 kΩ 1%	RN55	341489
R10	Resistor, Comp.	10 kΩ 5%	AB-EB	343400
R11	Resistor, MF	24.9 kΩ 1%	RN55	341438
R12	Resistor, MF	5.11 kΩ 1%	RN55	341368
R13	Resistor, MF	93.1 kΩ 1%	RN55	341493
R14	Resistor, MF	5.11 kΩ 1%	RN55	341368
R15	Resistor, Comp.	200 kΩ 5%	AB-EB	343529
R16	Resistor, Comp.	200 kΩ 5%	AB-EB	343529
R17	Resistor, MF	30.1 kΩ 1%	RN55	341446
R18	Resistor, MF	5.11 kΩ 1%	RN55	341368
R19	Resistor, Comp.	51 kΩ 5%	AB-EB	343468
R20	Resistor, MF	1.82 kΩ 1%	RN55	341325
R21	Resistor, Comp.	24 kΩ 5%	AB-EB	343437
R22	Resistor, Comp.	110 Ω 5%	AB-EB	343204
R23	Resistor, Comp.	100 Ω 5%	AB-EB	343200
R24	Not Used			
R25	Resistor, Comp.	51 kΩ 5%	AB-EB	343468
R26	Not Used			
R27	Resistor, MF	4.02 kΩ 1%	RN55	341358
R28	Resistor, Var.	1 kΩ 10% 0.5 W	Bourns 3329H-1-102	311404
R29	Not Used			
R30	Resistor, MF	4.02 kΩ 1%	RN55	341358
R31	Resistor, Comp.	1.2 kΩ 5%	AB-EB	343308
R32	Resistor, Comp.	100 Ω 5%	AB-EB	343200
R33	Resistor, WW	220 Ω 5% 2 W	Ohmite 42J220	310022
R34	Not Used			
R35	Resistor, Comp.	220 Ω 5%	AB-EB	343233
R36	Resistor, Comp.	220 Ω 5%	AB-EB	343233
R37	Resistor, Comp.	51 kΩ 5%	AB-EB	343468
R38	Resistor, Comp.	100 kΩ 5%	AB-EB	343500
R39	Resistor, Comp.	5.1 kΩ 5%	AB-EB	343368
R40	Resistor, Comp.	1 kΩ 5%	AB-EB	343300
R41	Resistor, MF	464 Ω 1%	RN55	341264
R42	Resistor, Var.	100 Ω 10% 0.5 W	Bourns 3329H-1-101	311406
R43	Resistor, MF	453 Ω 1%	RN55	341263
R44	Resistor, MF	10.0 kΩ 1%	RN55	341400
R45	Resistor, MF	4.99 kΩ 1%	RN55	341367
R46	Resistor, MF	12.7 kΩ 1%	RN55	341410
R47	Resistor, MF	2.21 kΩ 1%	RN55	341333
R48	Resistor, Var.	500 Ω 10% 0.5 W	Bourns 3329H-1-501	311405
R49	Resistor, MF	4.99 kΩ 1%	RN55	341367
R50	Resistor, MF	2.80 kΩ 1%	RN55	341343
R51	Resistor, MF	2.21 kΩ 1%	RN55	341333
R52	Resistor, Comp.	100 kΩ 5%	AB-EB	343500
R53	Resistor, Comp.	200 kΩ 5%	AB-EB	343529
R54	Resistor, Comp.	300 Ω 5%	AB-EB	343246
T1	Transformer, Ass'y.		Boonton Electronics	042175-1

Reference	Description			BEC Part No.
	MISCELLANEOUS			
	Cable Assembly (P.S. to Display)			571142
	Cable Assembly (P.S. to Input)			571143
	Cable Assembly (P.S. to Control 1)			571144
	Cable Assembly (P.S. to Control 2)			571145
	Cable Assembly (P.S. to Interface) (Option -01)			571147
	Cable Assembly (P.S. to Input) (Option -03)			571148
	Cable Assembly (Control to Display)			920046
	Cable Assembly (Control to Input)			920050
	INTERFACE PC BOARD ASSEMBLY (-01 OPTION)			
C1	Capacitor, Tant.	10 µF 20% 25 V	Sprague 196D106X0025KM1	283293
C2	Capacitor, Tant.	10 µF 20% 25 V	Sprague 196D106X0025KM1	283293
IC1	PROM	Programmed 4200-1	Boonton Electronics	534226
IC2	Resistor Network	3 k 2% 2 W	Beckman 784-1-R3K	534017
IC3	Integrated Circuit	AM8255	Advanced Micro Devices	534171
IC4	Integrated Circuit	SN74LS00N	T.I.	534167
IC5	Integrated Circuit	SN74LS04N	T.I.	534155
IC6	Integrated Circuit	SN7402N	T.I.	534027
IC7	Integrated Circuit	SN74LS74N	T.I.	534157
IC8	Integrated Circuit	N8T26AN	Signetics	534097
IC9	Integrated Circuit	N8T26AN	Signetics	534097
IC10	Integrated Circuit	SN7438N	T.I.	534108
IC11	Resistor Network	3 kΩ/6.2 kΩ 5% 2 W	National Semiconductor RA28-3K/6.2KN	345016
IC12	Resistor Network	3 kΩ/6.2 kΩ 5% 2 W	National Semiconductor RA28-3K/6.2KN	345016
J1	Connector	24 Pin	Amp 552230-1	479350
S1	Switch, Slide	7 Sw. Sections	CTS-206-7	465215
	MISCELLANEOUS, -01 OPTION			
	Cable Assembly (Input 1, Input 2, Control)		Boonton Electronics	920052
	Cable Assembly	1 M Long, HP 10631	HP-IB	571133
	CHARGER PC BOARD ASSEMBLY (-02 OPTION)			
A1	Integrated Circuit	CA3140AE	RCA	535050
C1	Capacitor, Cer.	1000 pF 10% 1 kV	Sprague 10TS-D10	224310
CR1	Diode, Sil.	VSK-140	VARO	532022
F1	Fuse, Slo-Blo	2.0 Amp.	Buss MDX-2A	545503
J1	Cable Assembly		Boonton Electronics	571150

Reference	Description			BEC Part No.
Q1	Transistor, NPN	2N3904	Motorola	528071
	Transistor, PNP	MJE-371	Motorola	528028
R1	Resistor, Comp.	100 Ω 5%	AB-EB	343200
R2	Resistor, Comp.	470 Ω 5%	AB-EB	343265
R3	Resistor, WW	1 Ω 5% 2 W	Omite 42J1RO	310021
R4	Resistor, MF	75.0 kΩ 1%	RN55	341484
R5	Resistor, MF	75.0 kΩ 1%	RN55	341484
R6	Resistor, MF	80.6 kΩ 1%	RN55	341487
R7	Resistor, Var.	10 kΩ 10% 0.5 W	Beckman 72PR10K	311328
R8	Resistor, MF	75.0 kΩ 1%	RN55	341484
R9	Resistor, Comp.	1 kΩ 5%	AB-EB	343300

MISCELLANEOUS, -02 OPTION

Cable Assembly		Boonton Electronics	571150
Battery Cell		Gould #7.OSCL	556006

SECOND INPUT CHANNEL (-03 OPTION)

(See Input PC Board Assembly Parts List)

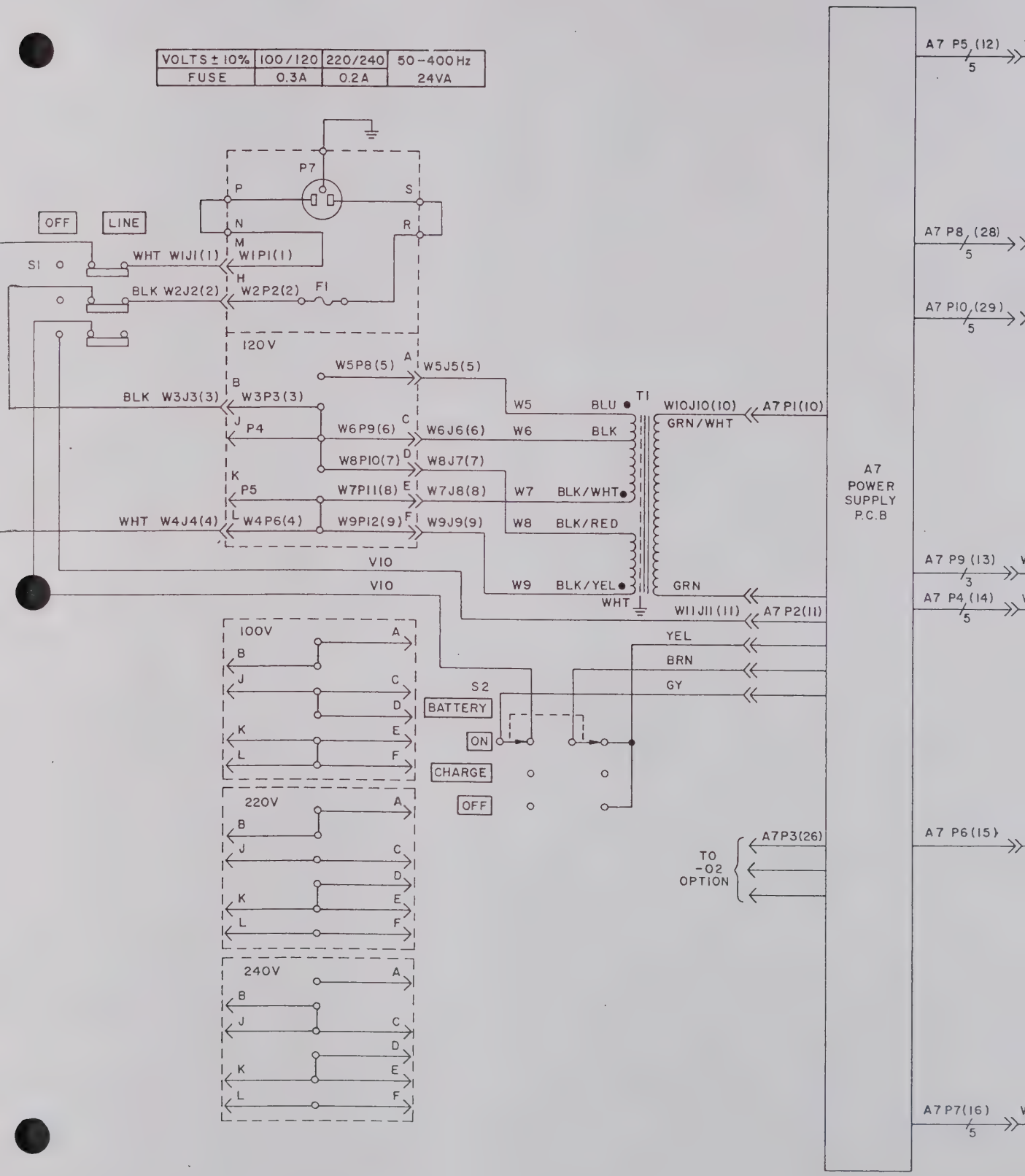
CHOPPER PC BOARD ASSEMBLY (-03 OPTION)

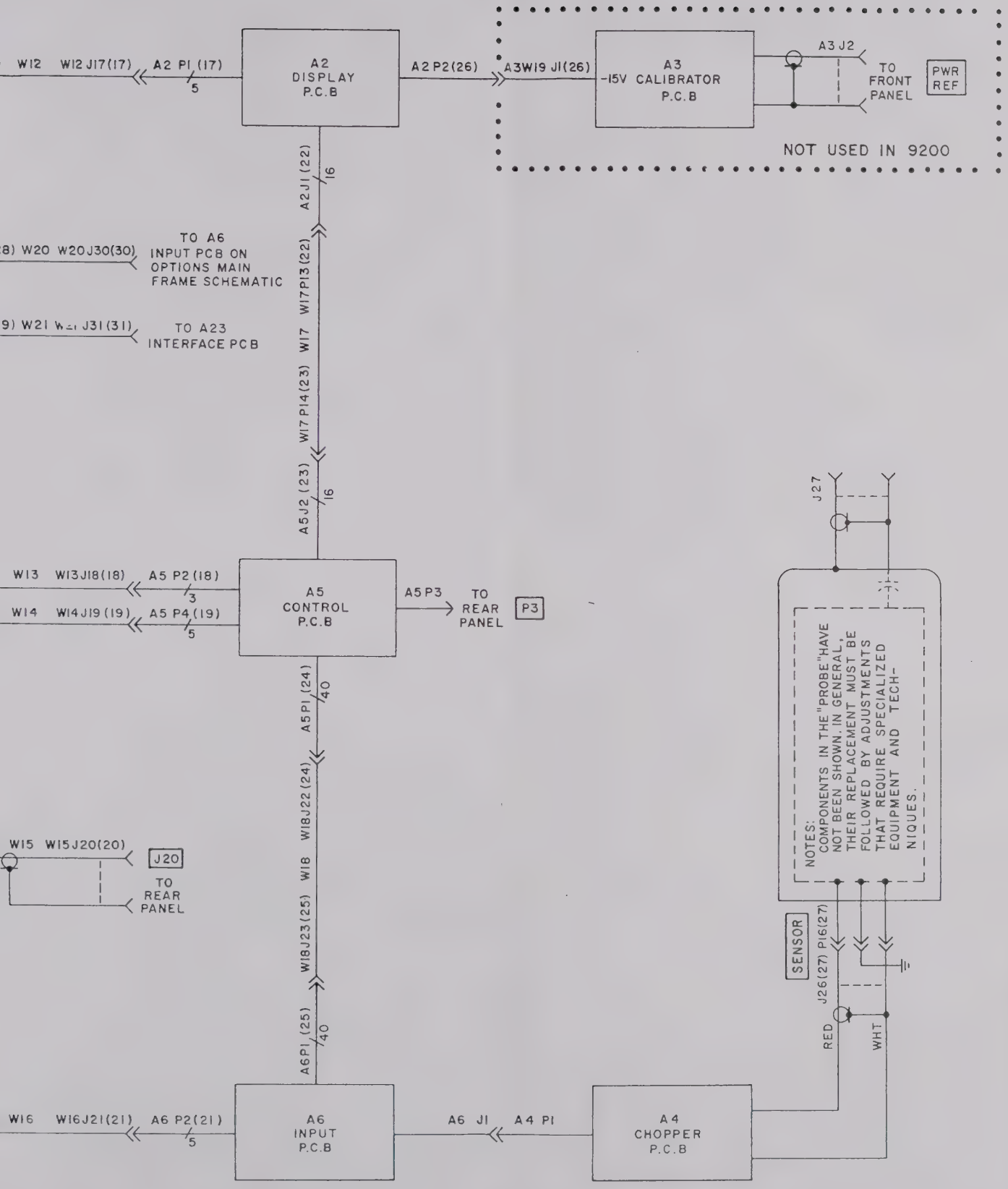
(See Chopper PC Board Assembly Parts List)

MISCELLANEOUS, -03 OPTION

Cable Assembly (Input 1, Input 2, Control, & Interface)	Boonton Electronics	920052
Connector	Amphenol 80-PC-2FT	479119

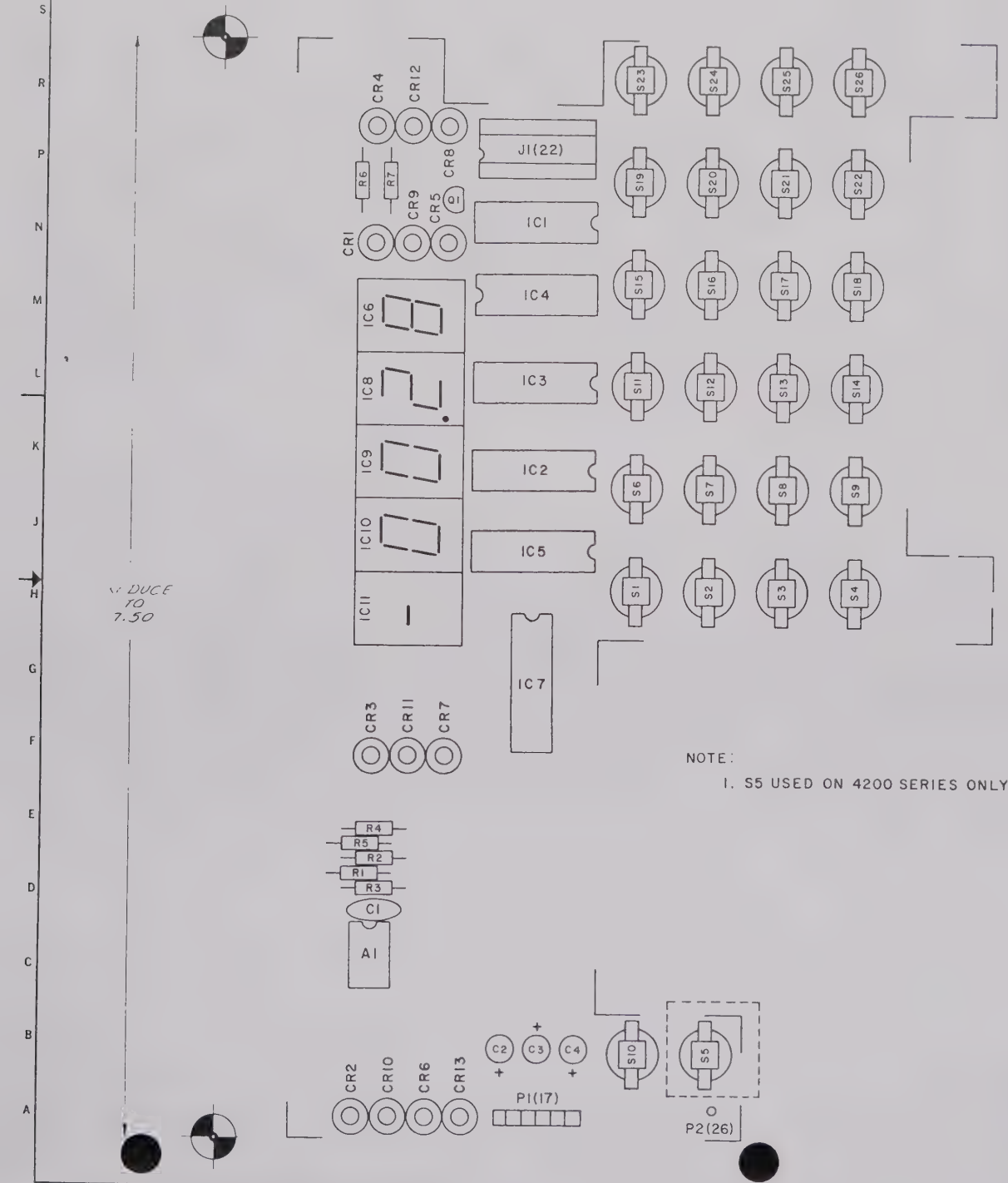
A1 MAIN FRAME





BOONTON ELECTRONICS CORPORATION

MODEL 4200
Schematic, Main Frame
E831053C Sht. 1 of 7



REDUCE TO 7.50

NOTE:

1. S5 USED ON 4200 SERIES ONLY.

ZONE	REV	DATE	SIG	DESCRIPTION

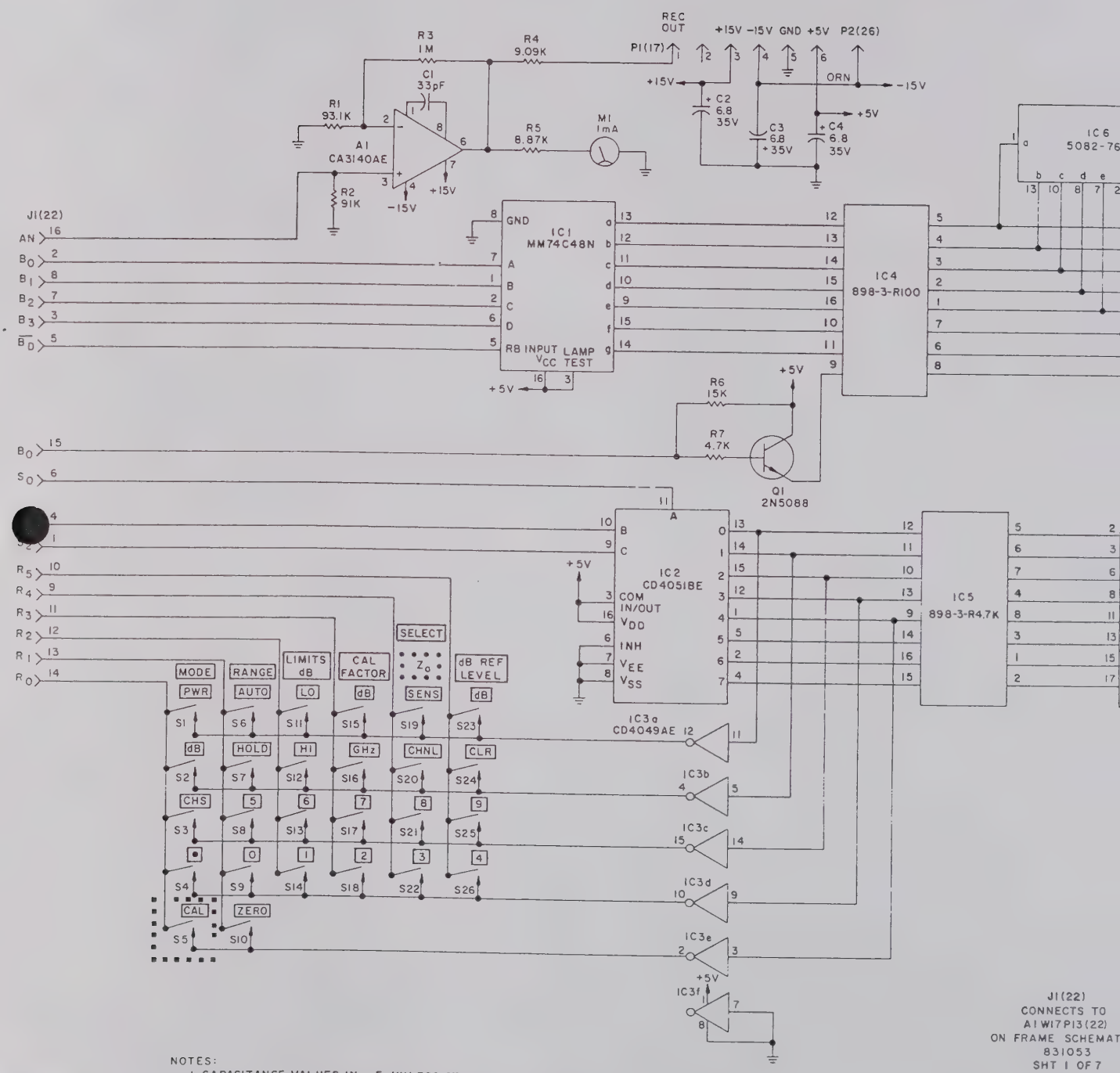
USED ON	TOLERANCES
4200	2 PLACE DECIMAL .010 3 PLACE DECIMAL .005 UNLESS OTHERWISE SPECIFIED
	SCALE 2:1
	DRN 4 11 79
	CKD
	APP

BOONTON ELECTRONICS PARSIPPANY NEW JERSEY

DISPLAY P.C. BOARD OVERLAY

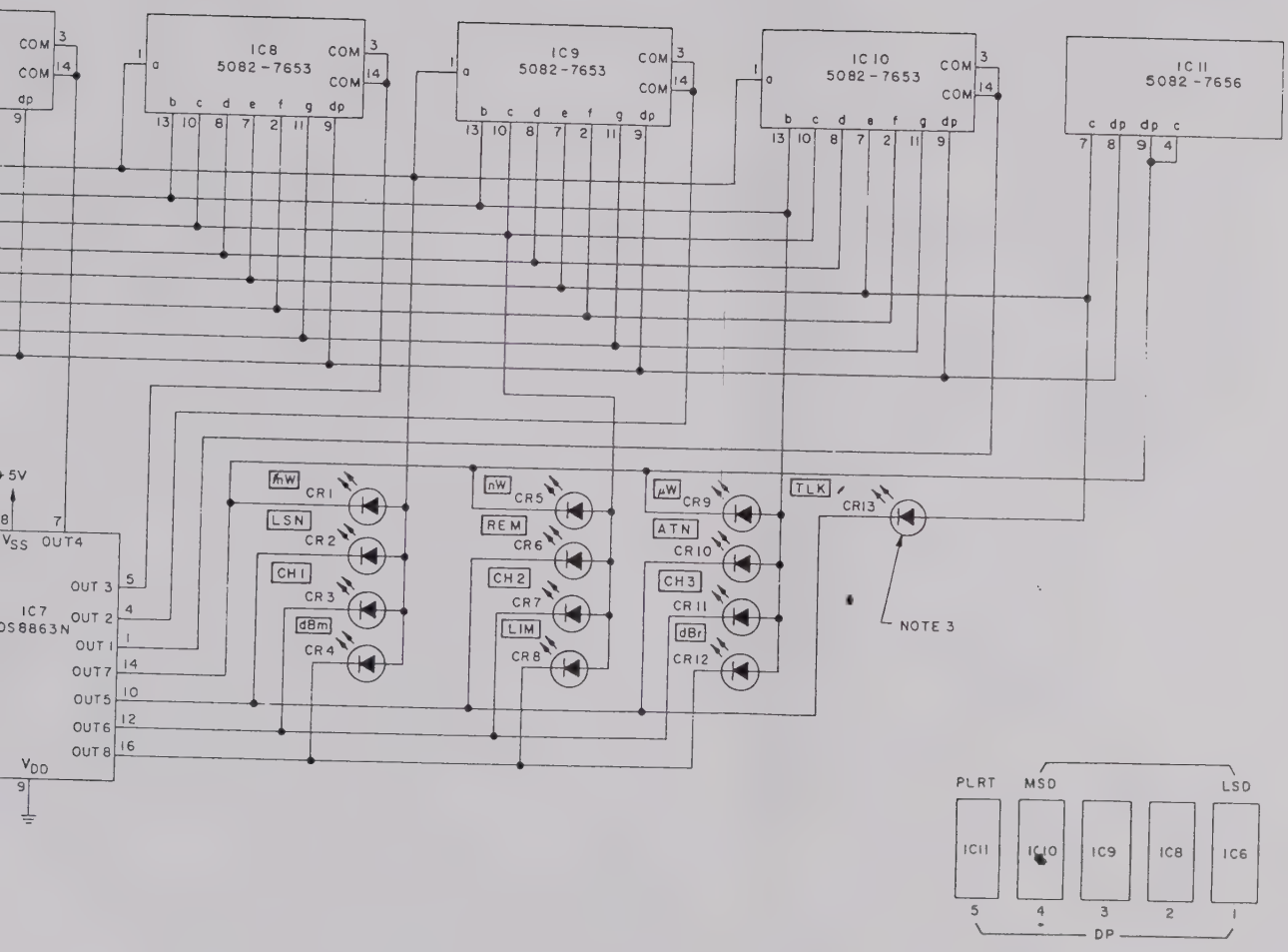
SH OF

A2 DISPLAY P.C. BOARD



NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUE IN OHMS UNLESS OTHERWISE SPECIFIED
3. ALL LED'S TO BE TYPE HLMP-1301 UNLESS OTHERWISE SPECIFIED.
4. ▭ EXTERNAL MARKINGS.
5. ⋮ USED ON 9200 SERIES ONLY.
6. LAST NUMBERS USED:
   R7 CR13 S26 IC11
7. ⋮ USED ON 4200 SERIES ONLY.

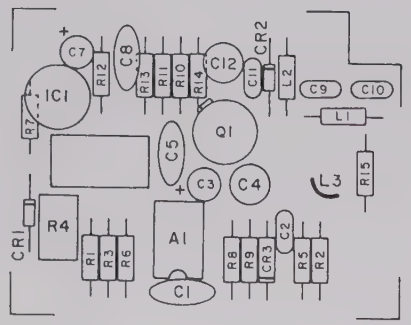


P1(17)
CONNECTS TO
A1W12J17(17)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

P2(26)
CONNECTS TO
A3W19J1(26)
ON FRAME SCHEMATIC (A1)
831053
SHT. 1 OF 7

REVISIONS				
ZONE	REV	DATE	SIG.	DESCRIPTION

M-11-79

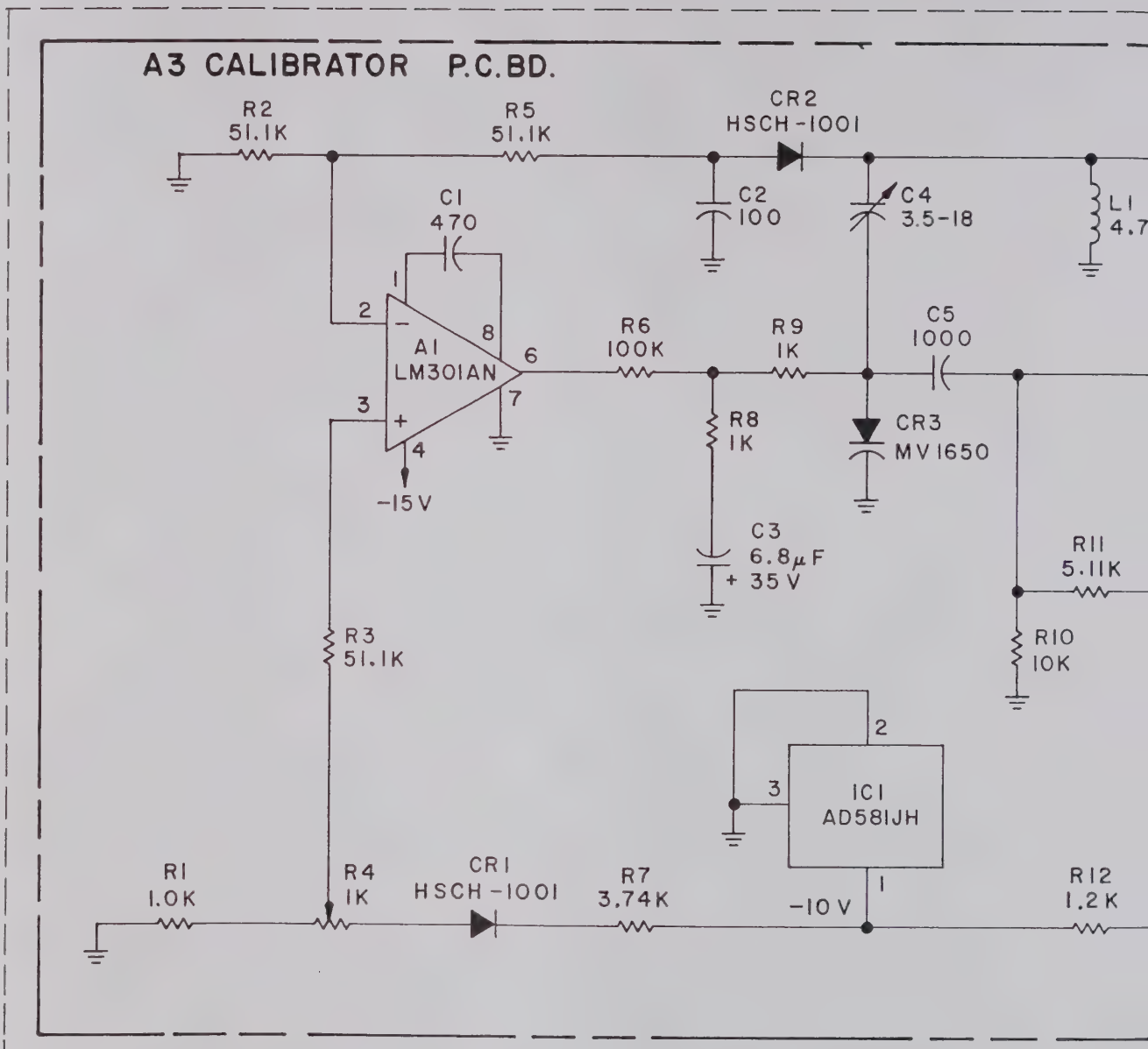


USED ON			TOLERANCES		
4.00			2 PLACE DECIMAL .010 3 PLACE DECIMAL .005 UNLESS OTHERWISE SPECIFIED		
			SCALE. 2:1		
			DRN	J.S.	4 5 79
			CKD		
			APP		

BOONTON ELECTRONICS PARSIPPANY NEW JERSEY

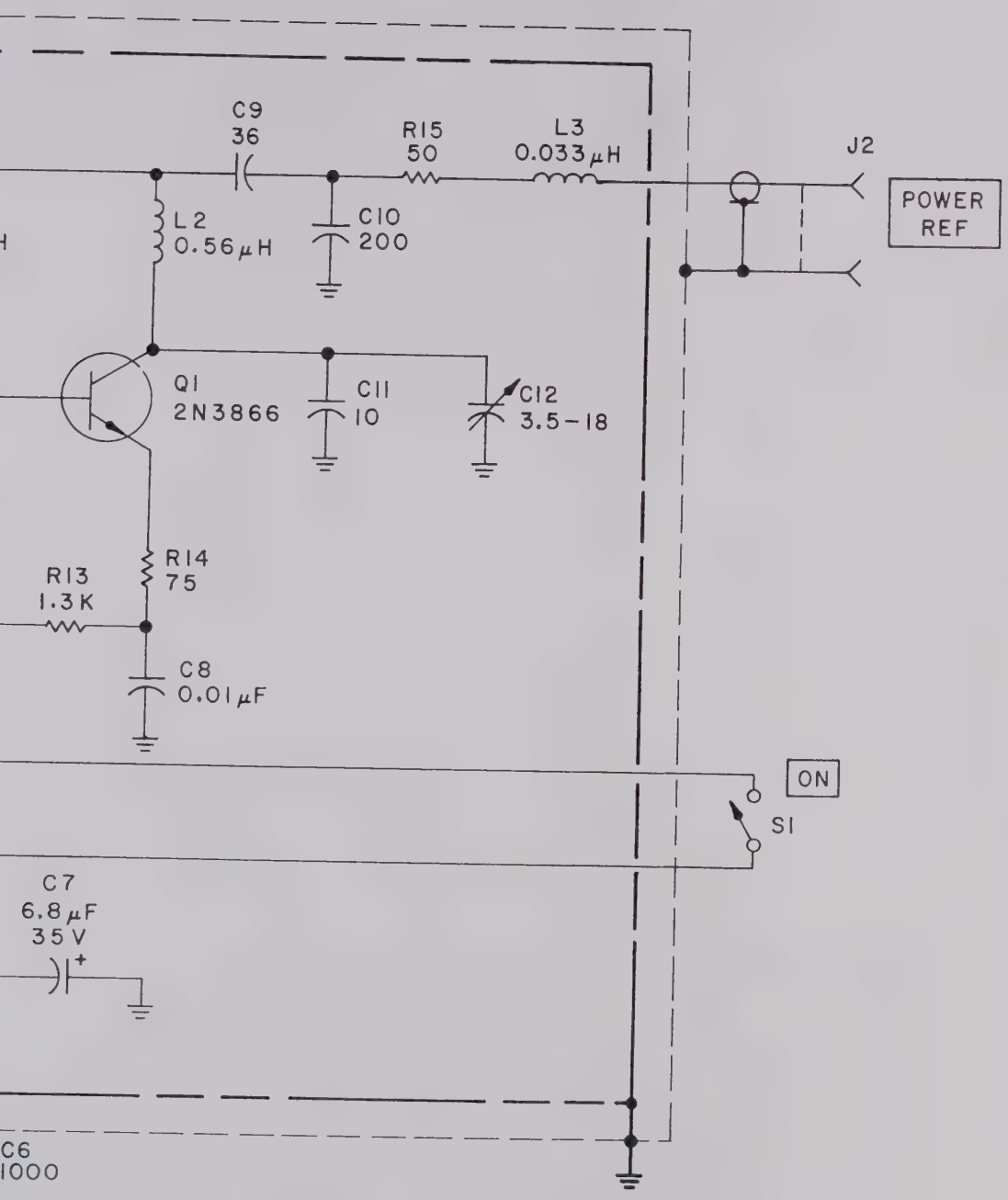
CALIBRATOR P.C. BOARD OVERLAY

SH. OF B 531044 A



NOTES:

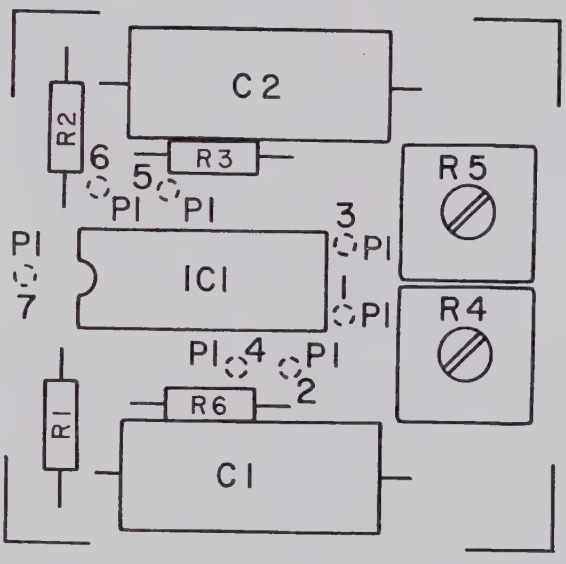
1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. [ ] EXTERNAL MARKINGS.
4. LAST NUMBERS USED:
   C12 R15



RN

JI(26)

JI(26)
CONNECTS TO
A2 P2(26)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7


C2
R2
R3
6
5
PI
PI
PI
3
PI
R5
PI
7
IC1
1
PI
R4
PI
4
PI
2
R6
R1
C1

M-11-79 REVISIONS				
ZONE	REV.	DATE	SIG.	DESCRIPTION
F-10 THRU F-12	B	5-30-79 6-11-79 7-16-79	B.S. T.D.H H.A.K.	ADDED PIN NUMBERS TO P1.

USED ON			TOLERANCES		
4200			2 PLACE DECIMAL .010 3 PLACE DECIMAL .005 UNLESS OTHERWISE SPECIFIED		
			SCALE: 2:1		
			DRN	B.S.	4-5-79
			CKD	T.D.H	4-6-79
			APP	H.A.K.	4-11-79

BOONTON ELECTRONICS CORPORATION PARSIPPANY NEW JERSEY

CHOPPER P.C. BOARD OVERLAY

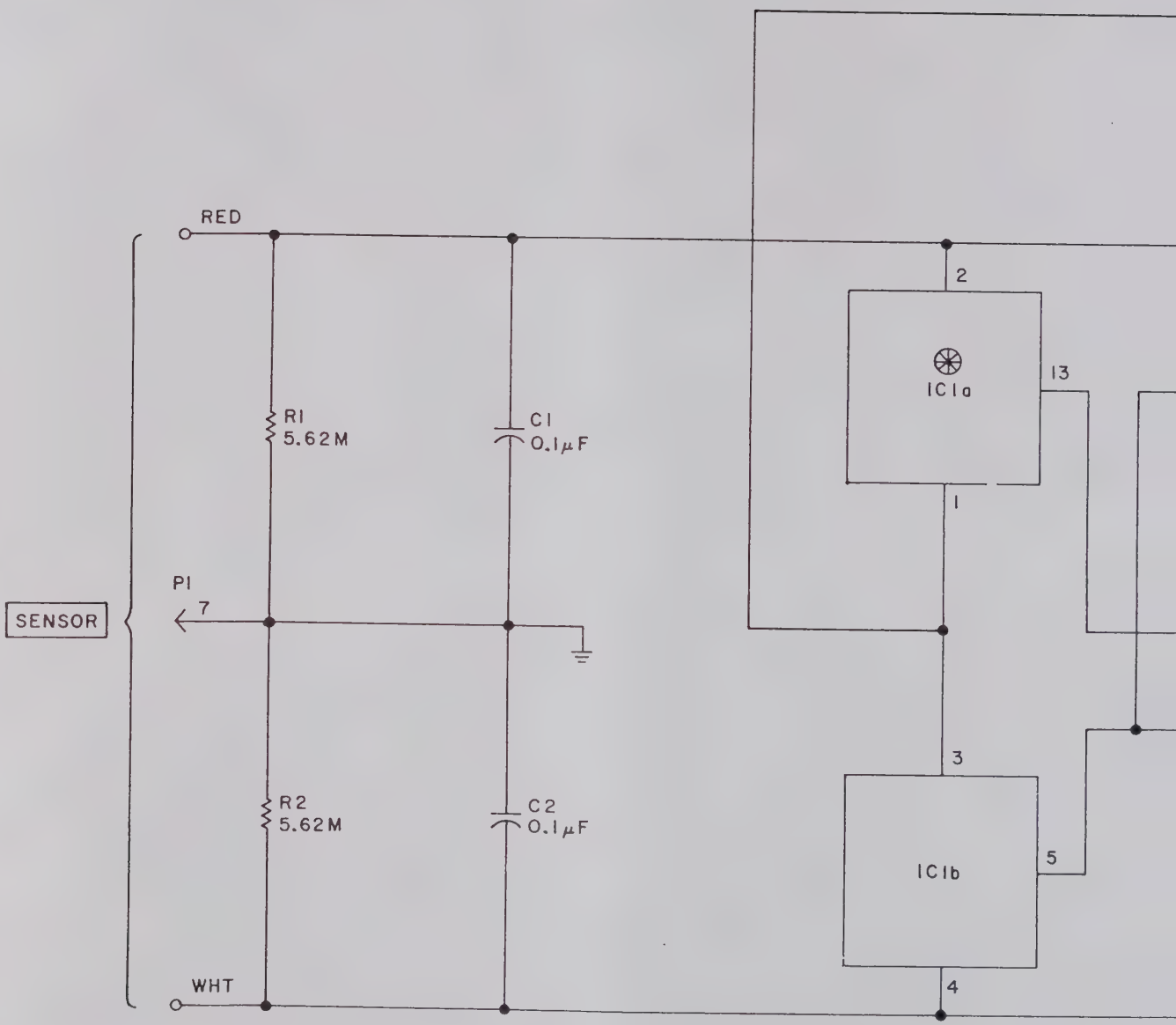
B

SH. OF

B 831045

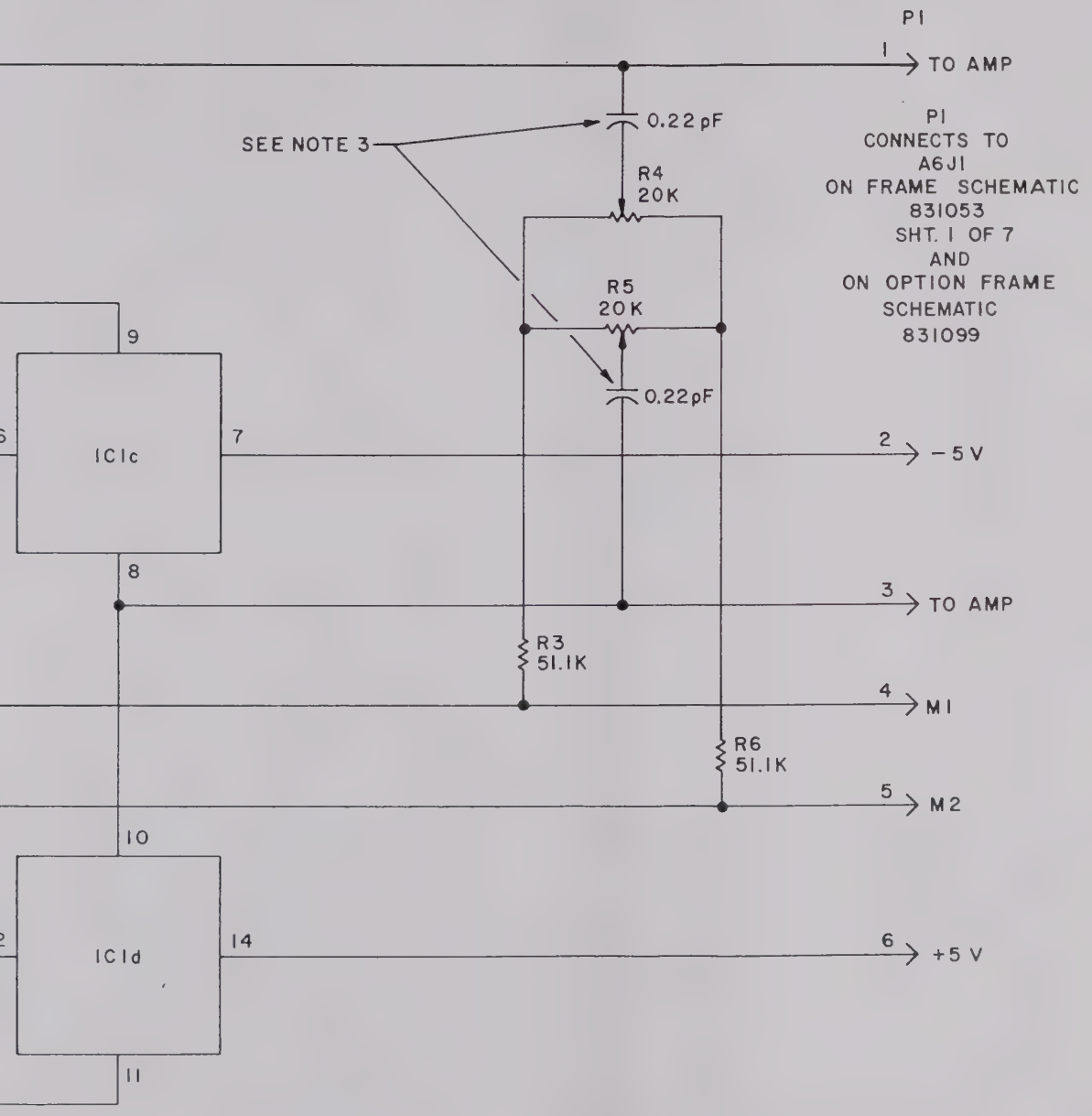
A

A4 CHOPPER P.C. BD.

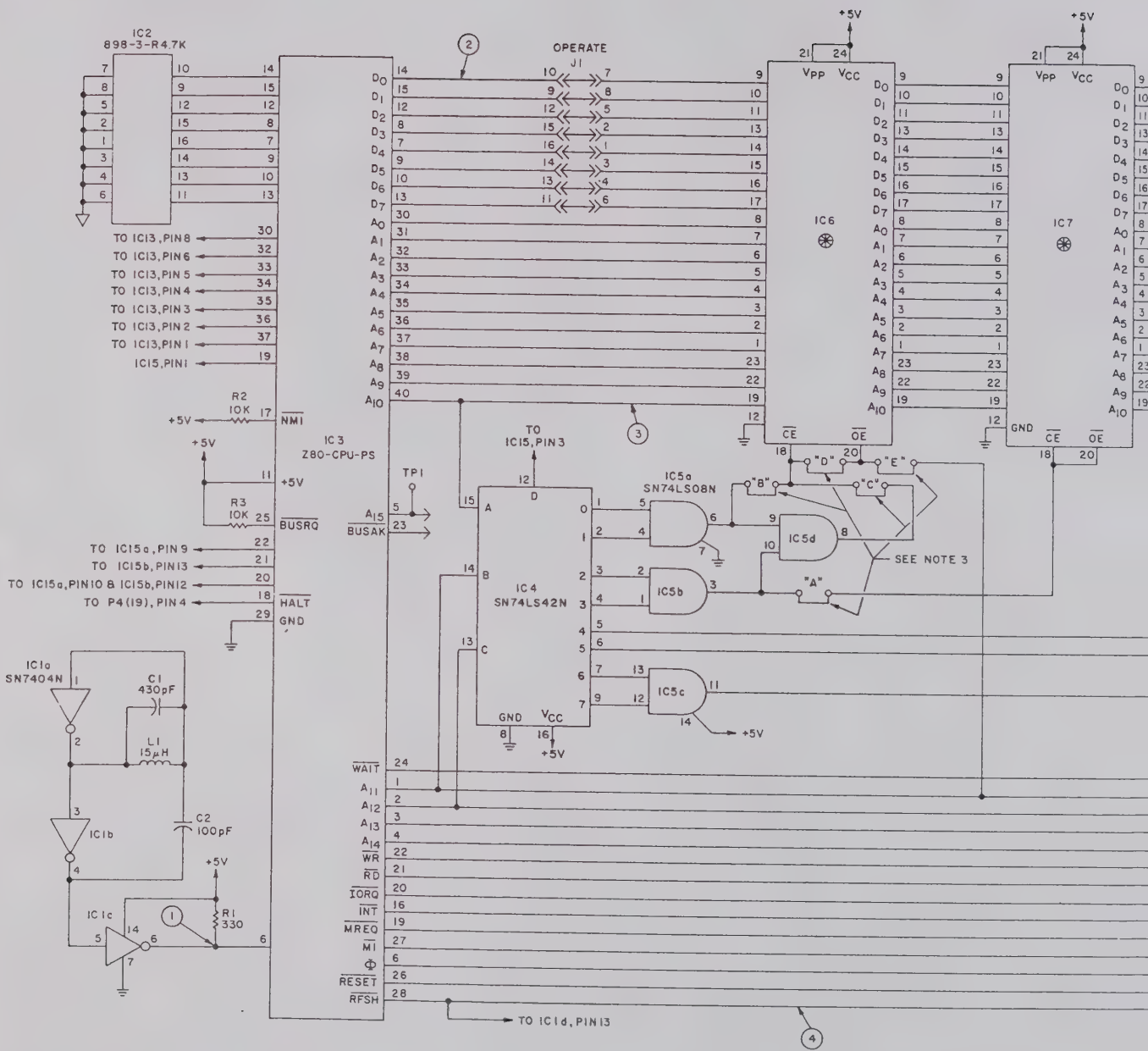


NOTES:

1. RESISTANCE VALUES IN OHMS.
2. ⊛ SELECTED VALUE.
3. CAPACITANCE IS PART OF P.C. BD. CIRCUITRY.
4. ▭ EXTERNAL MARKING.
5. LAST NUMBERS USED:
   R6

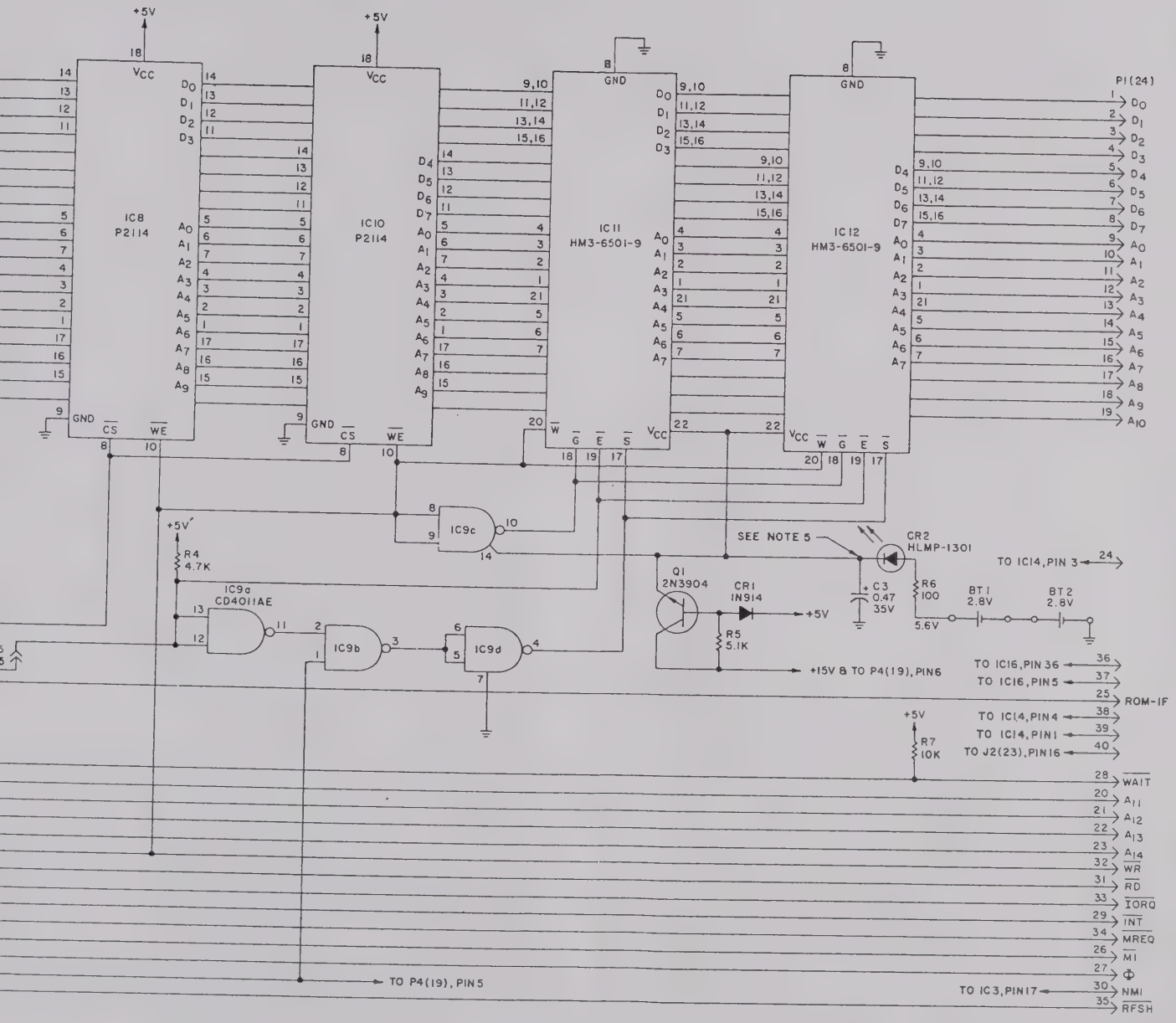

P1
1
TO AMP
0.22 pF
SEE NOTE 3
R4
20K
R5
20K
0.22pF
P1
CONNECTS TO
A6J1
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7
AND
ON OPTION FRAME
SCHEMATIC
831099
9
IC1c
7
2
-5 V
8
3
TO AMP
R3
51.1K
4
M1
R6
51.1K
5
M2
10
IC1d
14
6
+5 V
11

A5 CONTROL P.C. BOARD



NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. JUMPERS "A" & "B" & "D" ARE USED WHEN IC6 AND IC7 ARE 16K PROM'S OR ROM'S. JUMPER "C" & "E" ARE USED WHEN IC6 IS A 32K PROM OR ROM.
4. LAST NUMBERS USED:
   R7 C3 IC12
5. UNIT ON +5.2V, UNIT OFF NOM. +4.7V.
6. ◯ TEST POINT
7. ⊛ SELECTED VALUE.

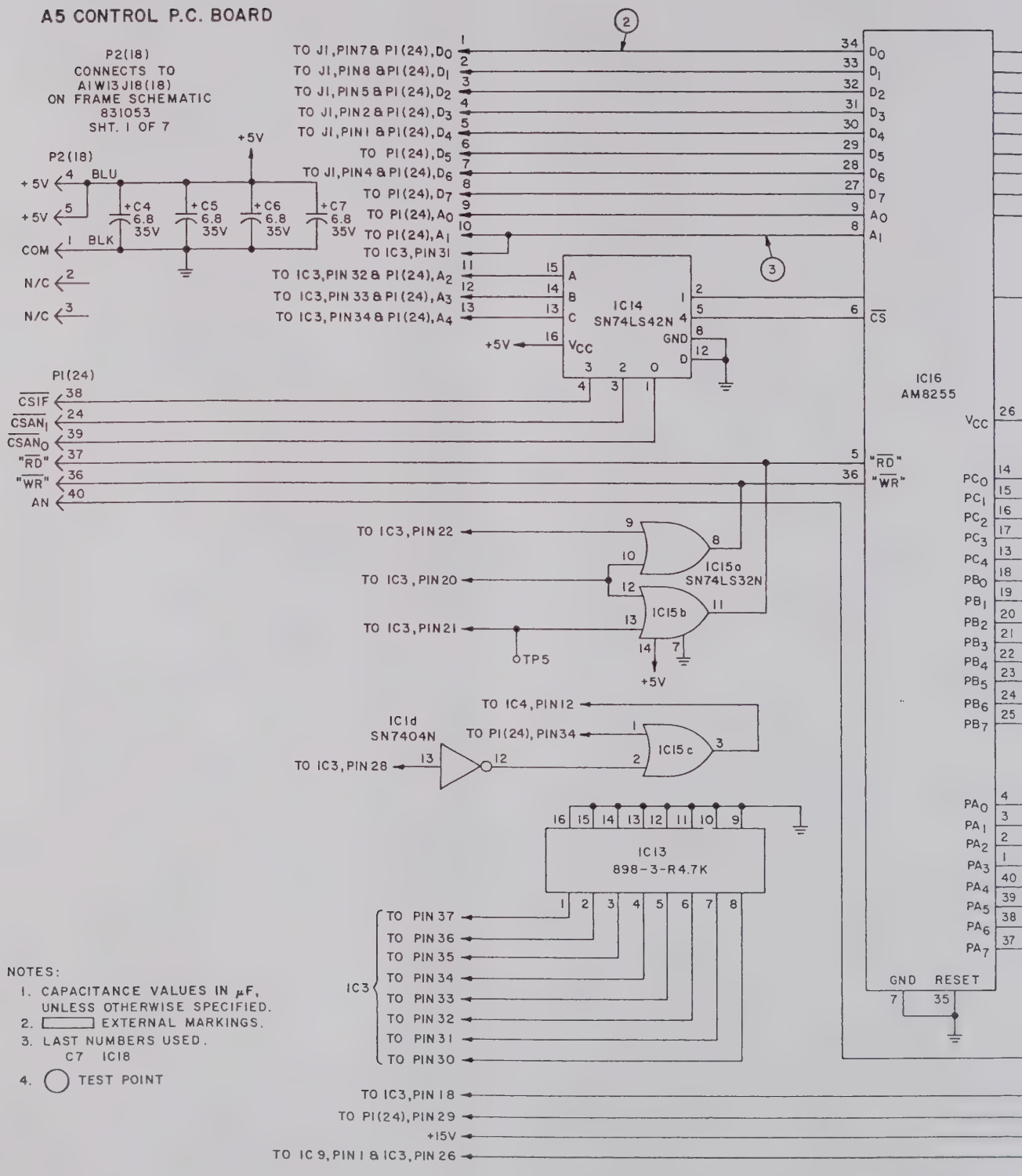


P1(24)
CONNECTS TO
A1W18 J22(24)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7
AND
CONNECTS TO
A20W20J24(24)
ON OPTIONS FRAME
SCHEMATIC
831099

BOONTON ELECTRONICS CORPORATION

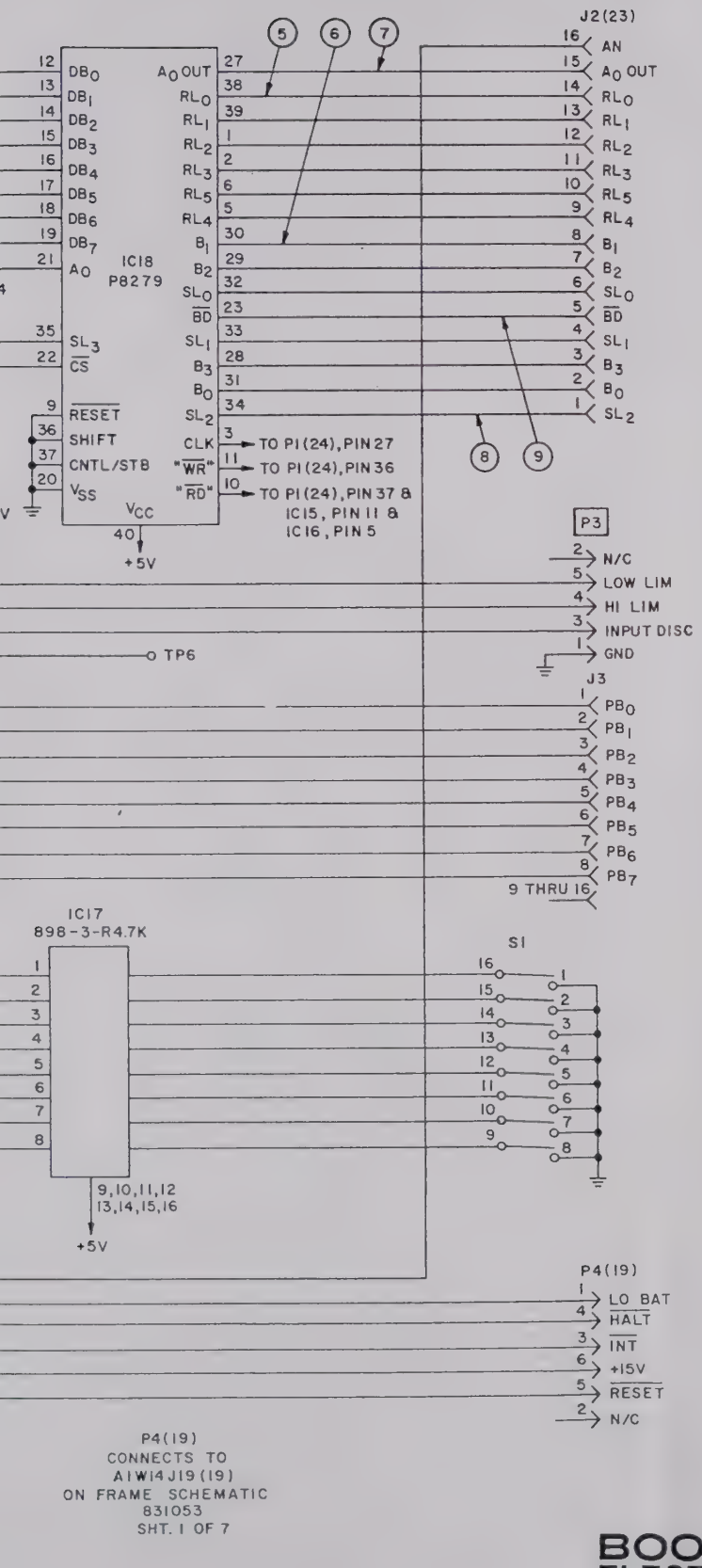
MODEL 4200
Schematic, Control PCB
E831053D Sht. 5a of 7

A5 CONTROL P.C. BOARD



NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. [ ] EXTERNAL MARKINGS.
3. LAST NUMBERS USED.
   C7 IC18
4. ○ TEST POINT



BOONTON ELECTRONICS CORPORATION

MODEL 4200
Schematic, Control PCB
D831053B Sht. 5b of 7

32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17

P3

IC13

P4(19)

J3

TP6

OPEN 1 2 3 4 5 6 7 8

S1

IC17

L1

C1

IC16

IC15

IC14

TP1

R4

IC5

IC4

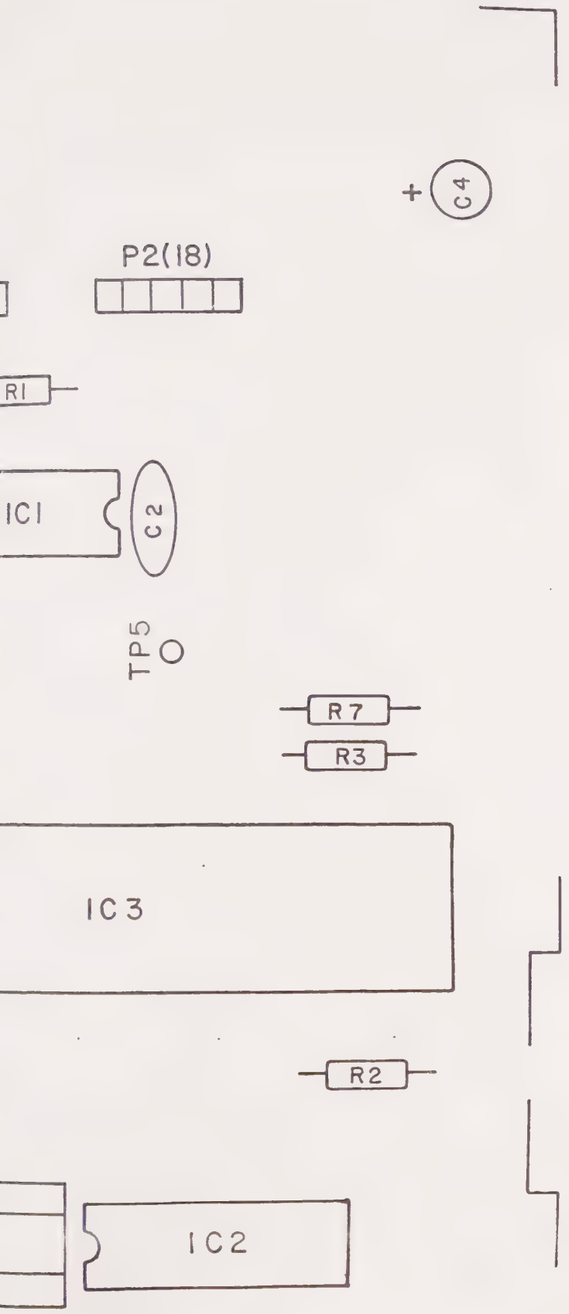
"C" "B" "A" (SEE NOTE)

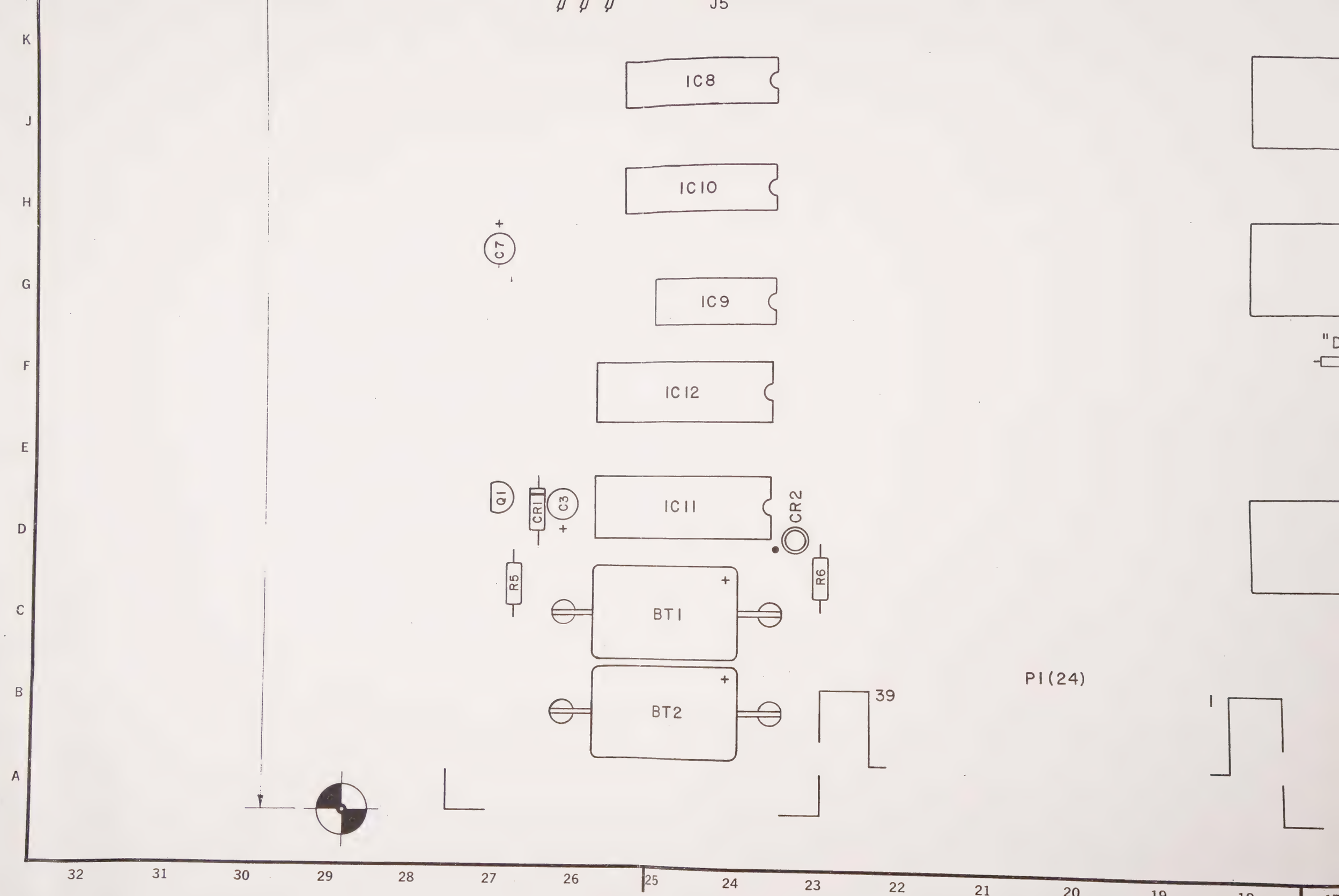
REDUCE TO 10.05

16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

REVISIONS				
ZONE	REV.	DATE	SIG.	DESCRIPTION
V-T 26-15. K-J 27 F 17-16	B	1-22-80 1-24-80 1-28-80 29JAN80	T.D.H J.F.D. [illegible] [illegible]	ADDED "TP5" & "TP6". DELETED "TP3" & "TP2". ADDED JUMPERS "D" & "E". ECN 327

Y W V U T S R P




J5
IC8
IC10
C7
IC9
IC12
Q1
CR1
C3
IC11
CR2
R5
R6
BT1
BT2
P1(24)
39
1
K
J
H
G
F
E
D
C
B
A
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18

C7

C6

"E"

TP4

C5

IC18

C6

J2(23)

NOTE:

ADD "A" AND "B" JUMPERS WHEN IC6 & IC7 ARE 2K PROM'S OR ROM'S.
ADD "C" JUMPER WHEN IC6 IS A 4K PROM OR ROM.

USED ON	TOLERANCES		
4200	2 PLACE DECIMAL .010 3 PLACE DECIMAL .005 UNLESS OTHERWISE SPECIFIED		
	SCALE:	2:1	
	DRN	B.S.	4-10-79
	CKD	T.H.	5-4-79
	APP	[illegible]	[illegible]

BOONTON ELECTRONICS CORPORATION PARSIPPANY, NEW JERSEY

CONTROL P.C. BOARD OVERLAY

SH. OF D 831056 B A

16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

K J H G F E D C B A

32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17

A B C D E F G H J K

P3

IC13

P4(19

J3

TP6

OPEN 8 7 6 5 4 3 2 1

S1

IC17

L1

C1

IC16

TP1

IC15 IC14

R4

IC5 IC4

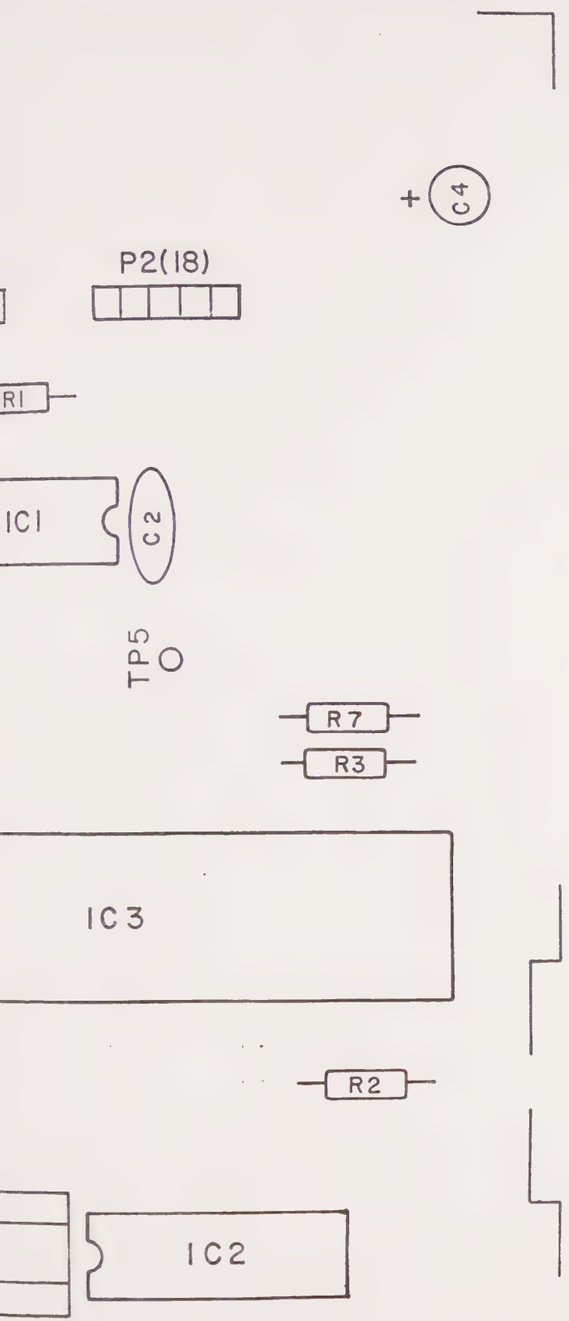
"C" "B" "A" (SEE NOTE)

REDUCE TO 10.05

16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

REVISIONS				
ZONE	REV.	DATE	SIG.	DESCRIPTION
V-T 26-15. K-J 27 F 17-16	B	1-22-80 1-24-80 1-28-80 29JAN80	T.D.H J.F.D. [illegible]	ADDED "TP5" & "TP6". DELETED "TP3" & "TP2". ADDED JUMPERS "D" & "E". ECN 327

Y W V U T S R P N



J5

IC8

IC10

C7

IC9

IC12

Q1

CR1

C3

IC11

CR2

R5

R6

BT1

BT2

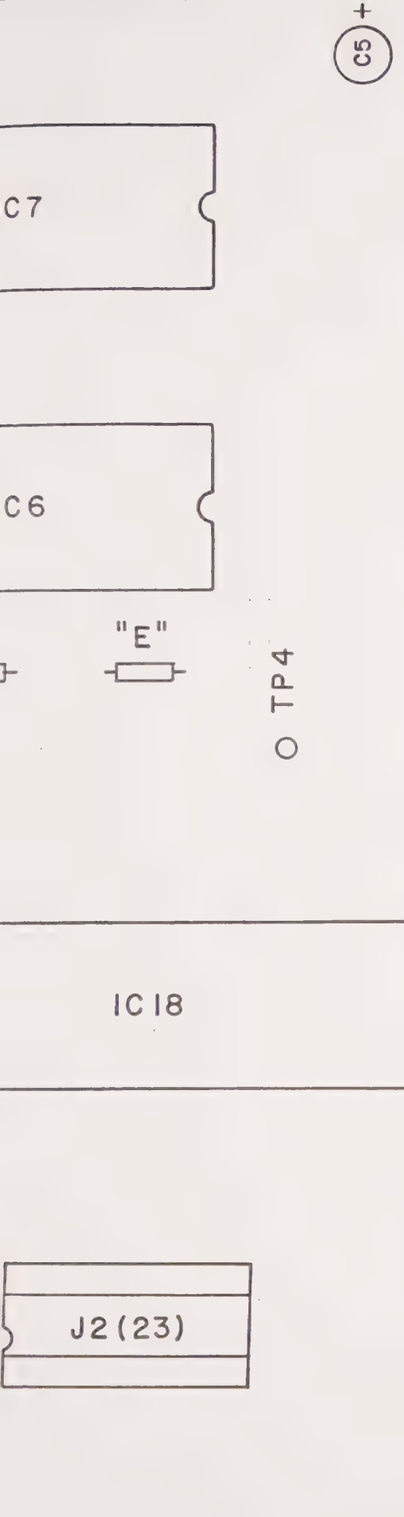
P1(24)

39

1

K J H G F E D C B A

32 31 30 29 28 27 26 25 24 23 22 21 20 19 18



NOTE:

ADD "A" AND "B" JUMPERS WHEN IC6 & IC7 ARE 2K PROM'S OR ROM'S.
ADD "C" JUMPER WHEN IC6 IS A 4K PROM OR ROM.

USED ON	TOLERANCES		
4200	2 PLACE DECIMAL .010 3 PLACE DECIMAL .005 UNLESS OTHERWISE SPECIFIED		
	SCALE:	2:1	
	DRN	B.S.	4-10-79
	CKD	T.D.H	5-4-79
	APP	[illegible]	[illegible]

BOONTON ELECTRONICS CORPORATION PARSIPPANY, NEW JERSEY

CONTROL P.C. BOARD OVERLAY

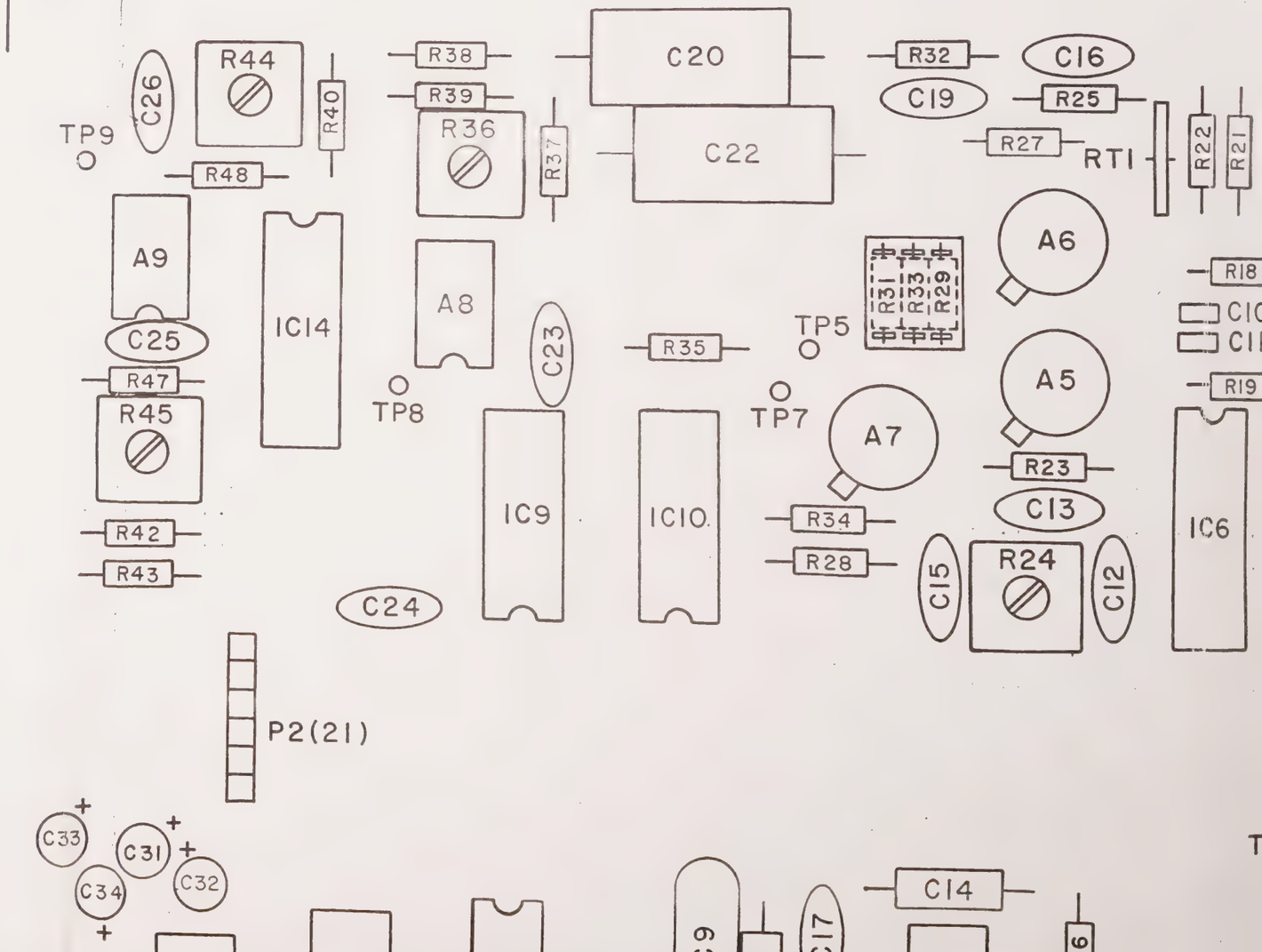
SH. OF D 831056 B A

16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

K J H G F E D C B A

32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17

REDUCE TO 6.40



16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

M-11-79

REVISIONS				
ZONE	REV.	DATE	SIG.	DESCRIPTION
U-5 20-19	B	1-14-80 1-18-80 1-22-80 1-31-80	T.D.H J.F.D. A.R.W. A.R.W.	RELOCATED C19 & R27. ADDED CONNECTOR WITH R29, R31 & R33. RELOCATED C51. DECREASED LENGTH OF JUMPER "B" & INCREASED LENGTH OF JUMPER "A". RCN 324
T-N 26-21	C	2-13-80 2-15-80 2-20-80	T.D.H J.F.D. A.R.W.	DELETED R49, R41, R50, R46, TP10 & C21. RCN 338
J/M- 21/23	D	3-24-80 3-25-80 3-25-80	A.R. J.F.D. A.R.W.	ADDED C35, INCREASED SIZE OF C9, REVISED AREA FOR SPACING. RCN 368

Y W V U T S R P N M

J1(2) J1(4)

J1(1)

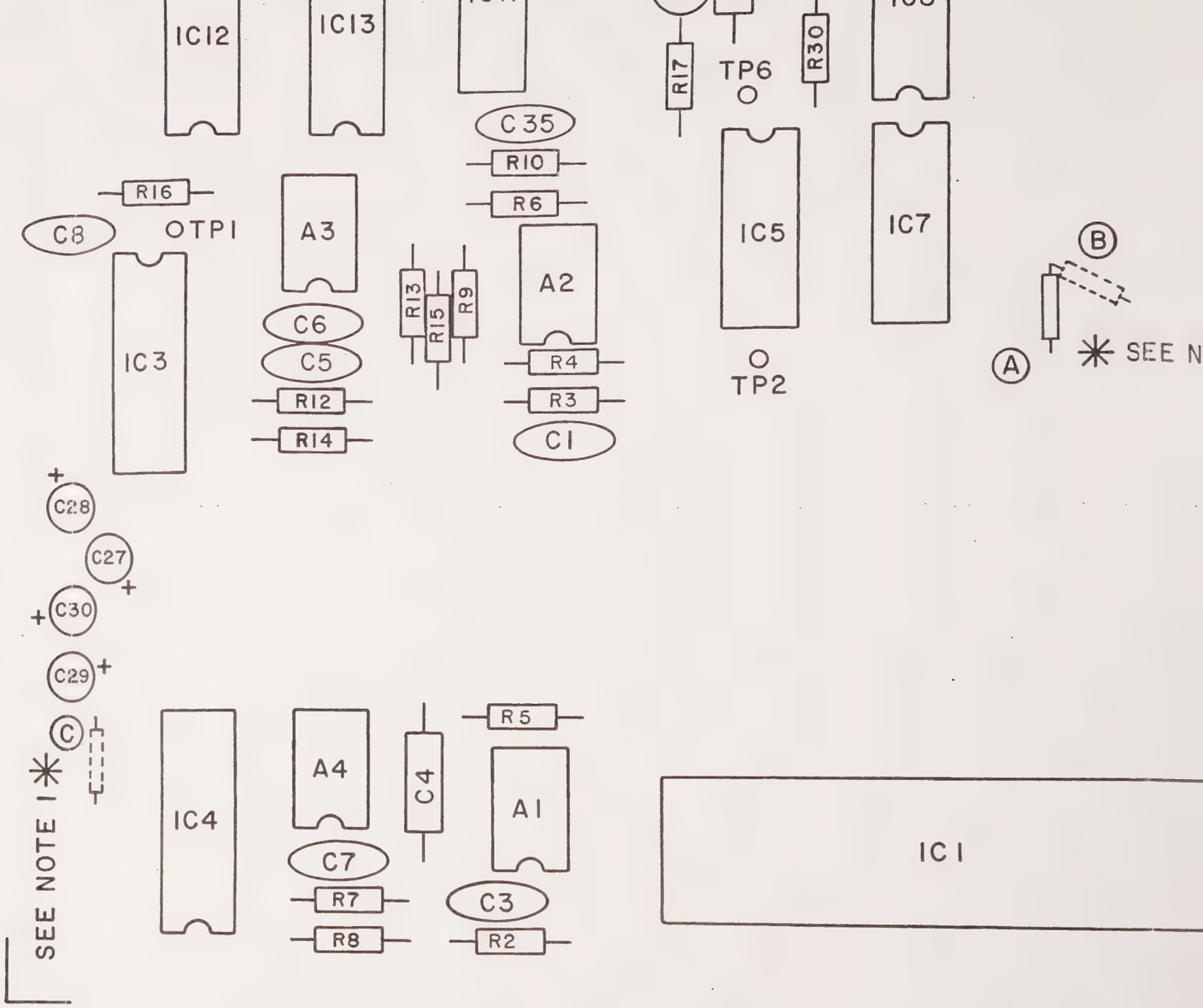
J1(7)

J1(3)

J1(5) J1(6)

TP3

40
38
36
34
32
30
28
26

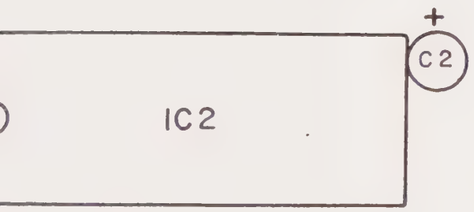


NOTES:

1. ✳ CHANNEL 1 ADD JUMPERS (B) & (C) ONLY.
   CHANNEL 2 ADD JUMPER (A) ONLY.
   REMOVE (B) & (C).

P1(25)
22
20
18
16
14
12
10
8
6
4
2

E 1



USED ON			TOLERANCES		
4200			2 PLACE DECIMAL .010 3 PLACE DECIMAL .005 UNLESS OTHERWISE SPECIFIED		
			SCALE: 2:1		
			DRN	B.S.	4-16-79
			CKD	T.D.H	5-4-79
			APP	H.E.K.	5-25-79

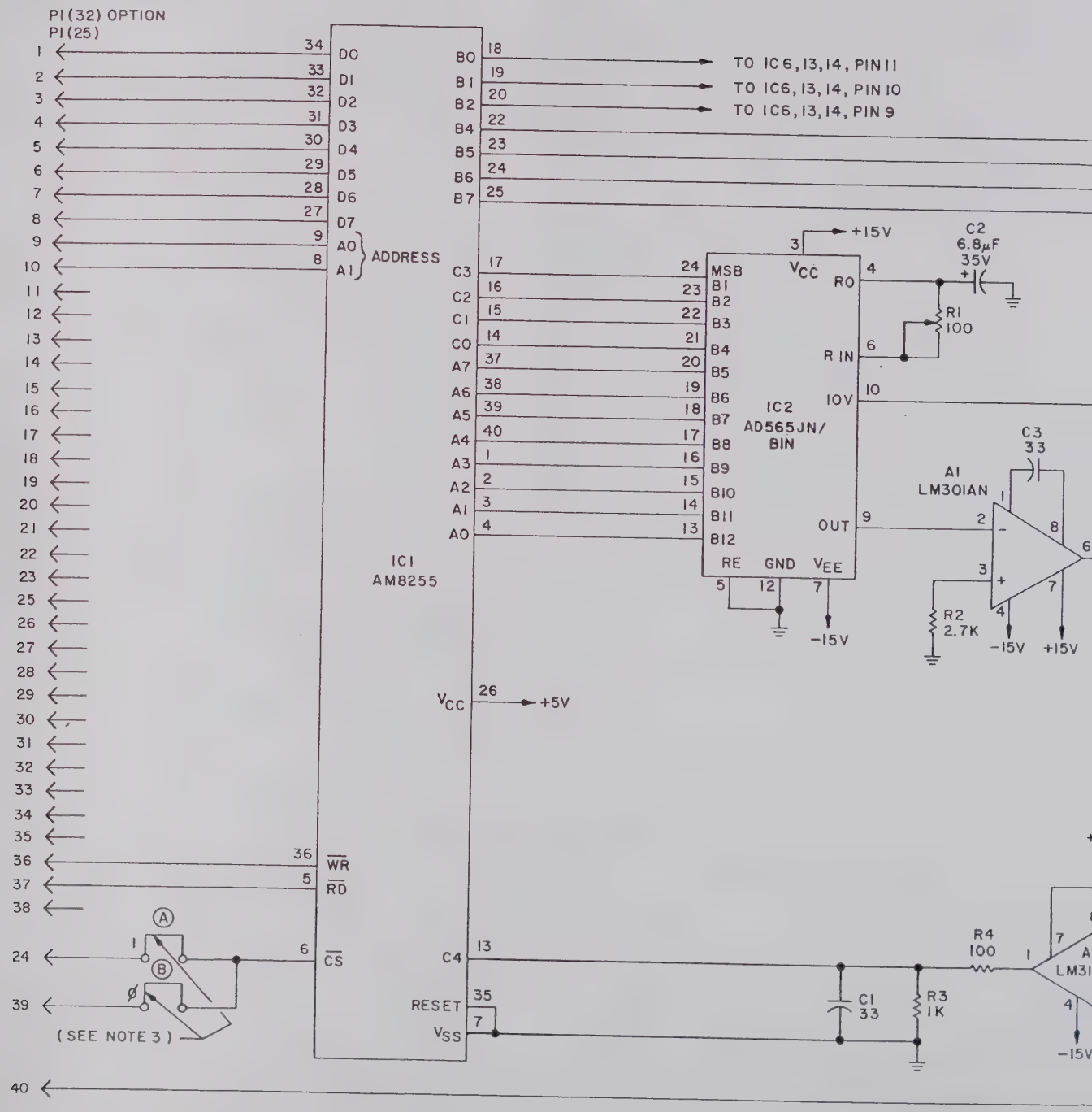
BOONTON ELECTRONICS CORPORATION PARSIPPANY, NEW JERSEY

INPUT MODULE P.C. BOARD OVERLAY

SH. OF D831055

16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

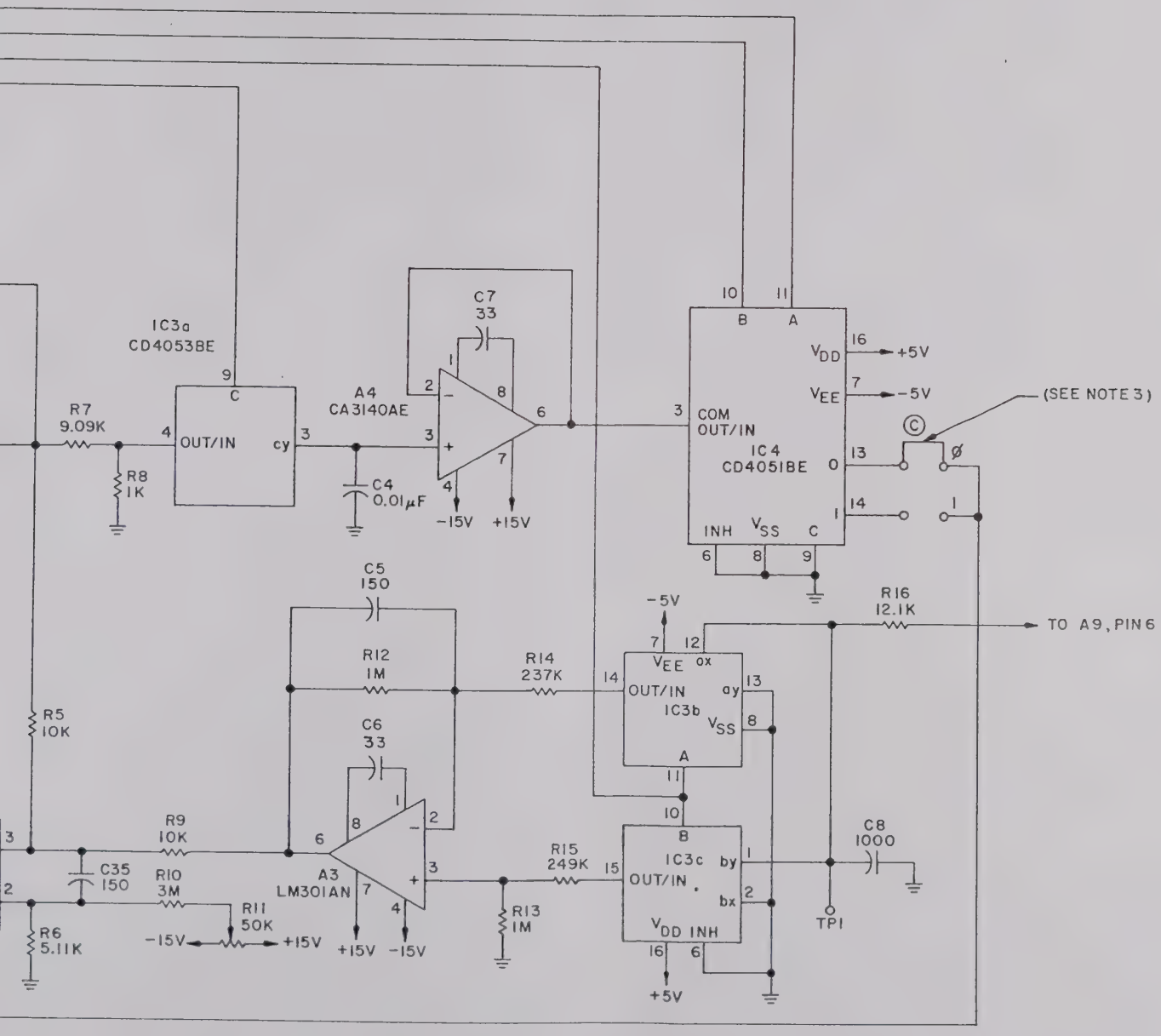
A6 INPUT MODULE P.C. BD.



NOTES:

1. CAPACITANCE VALUES IN pF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS, UNLESS OTHERWISE SPECIFIED.
3. CHANNEL 1 ADD JUMPERS (B) & (C) ONLY.
   CHANNEL 2 ADD JUMPER (A) ONLY,
   REMOVE (B) & (C).

P1(25)
CONNECTS TO
A1W18 J23(25)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

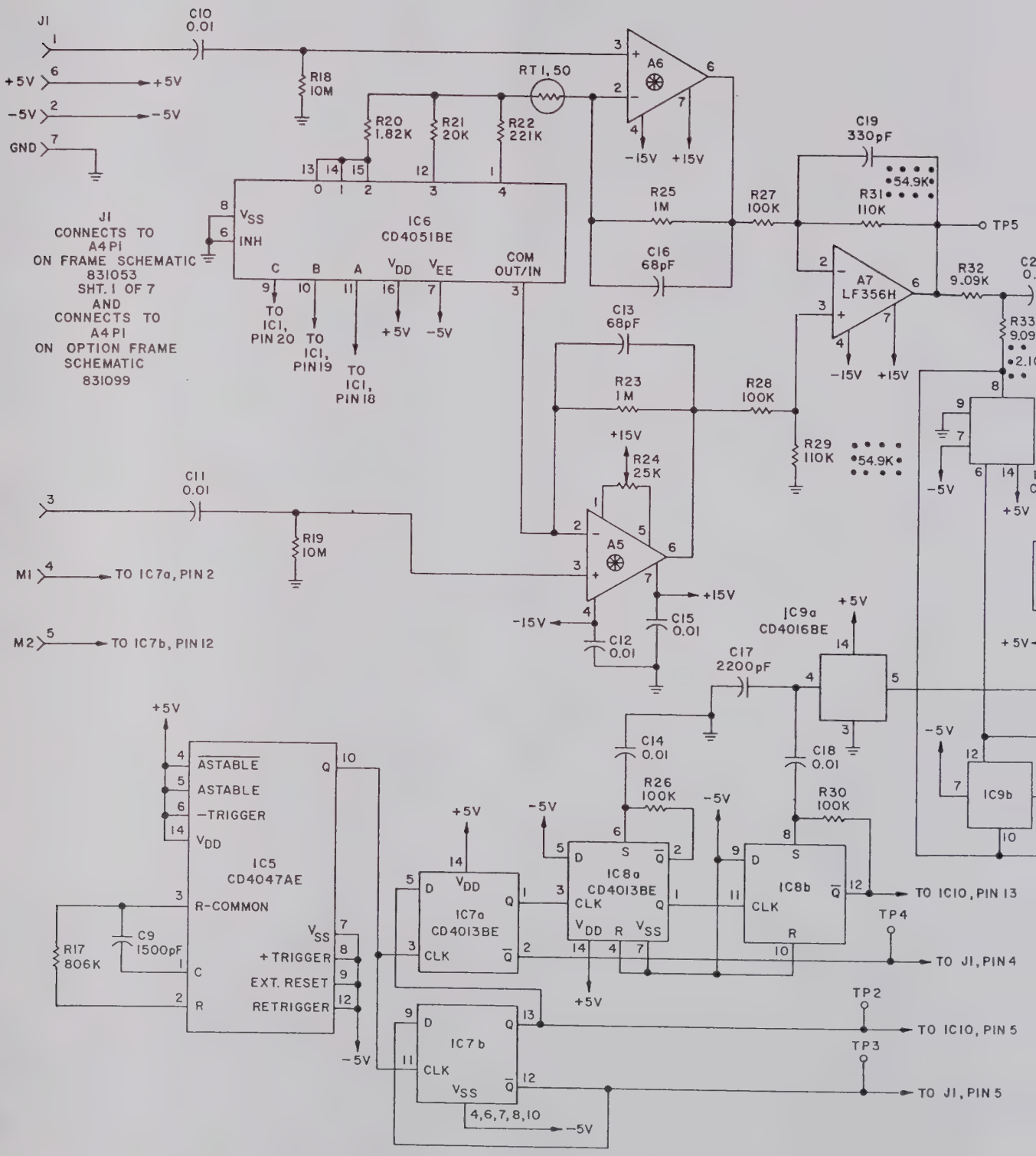


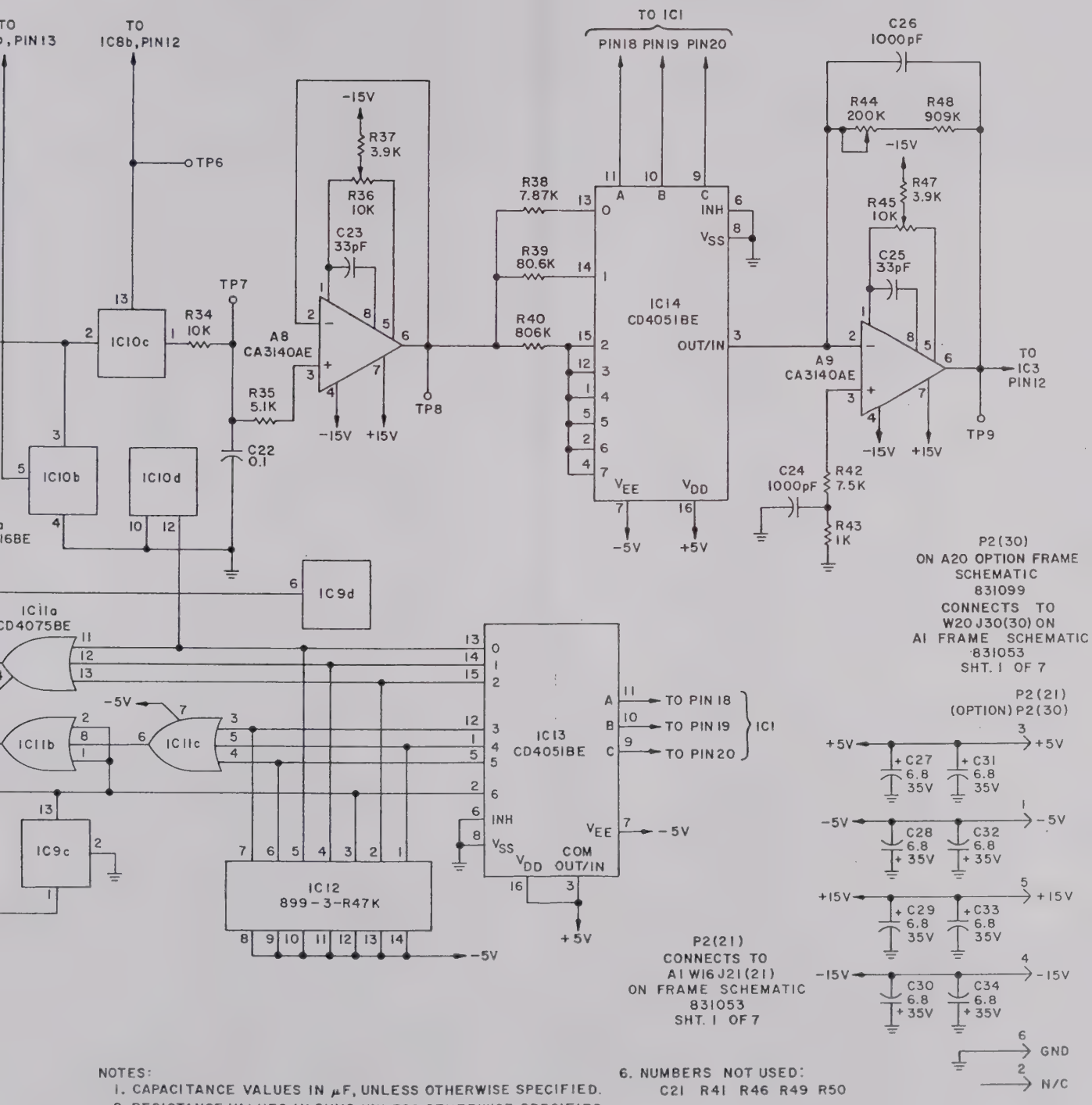
P1(32)
CONNECTS TO
A20W20J29(32)
ON OPTION FRAME
SCHEMATIC
831099

BOONTON ELECTRONICS CORPORATION

MODEL 4200, 9200
Schematic, Input Module PCB
D831053C Sht. 6a of 7

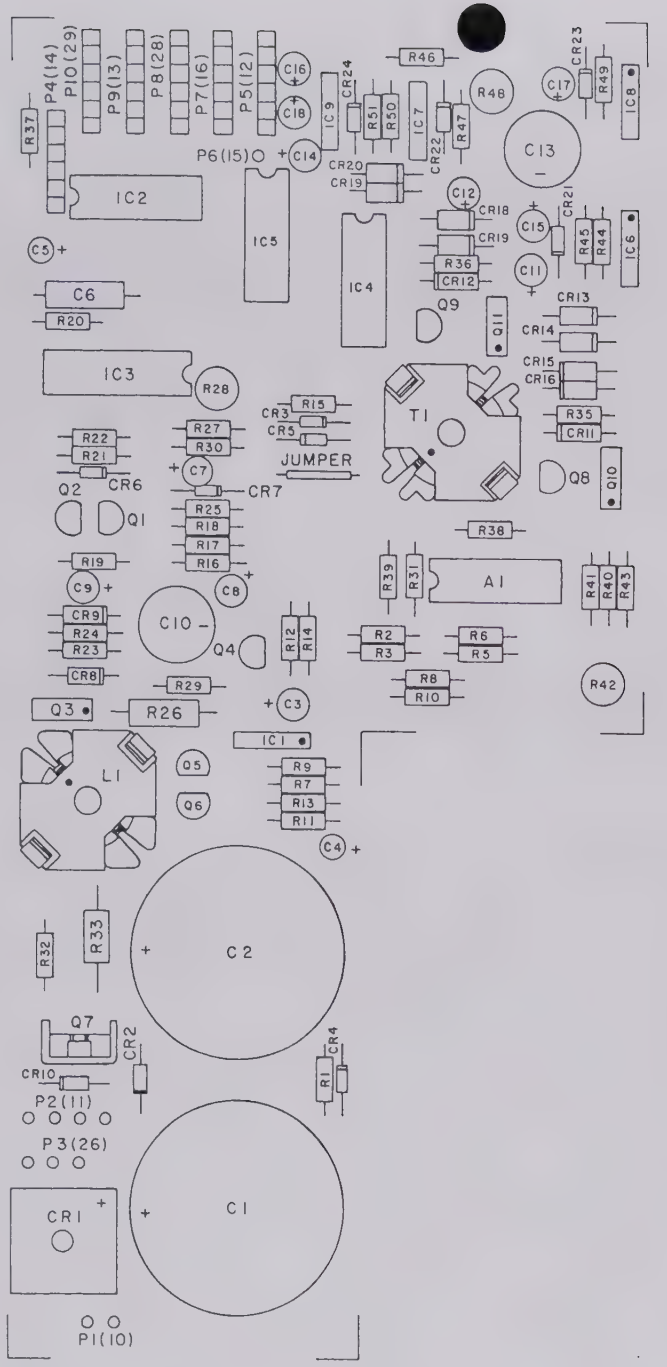
A6 INPUT MODULE P.C.BD.





NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS, UNLESS OTHERWISE SPECIFIED.
3. ⋯ THESE VALUES USED ON 9200 ONLY.
4. LAST NUMBERS USED:
   R48 C35 A9 IC14
5. ⊛ FACTORY SELECTED.
6. NUMBERS NOT USED:
   C21 R41 R46 R49 R50



ZONE	R	TE		DESCRIPTION

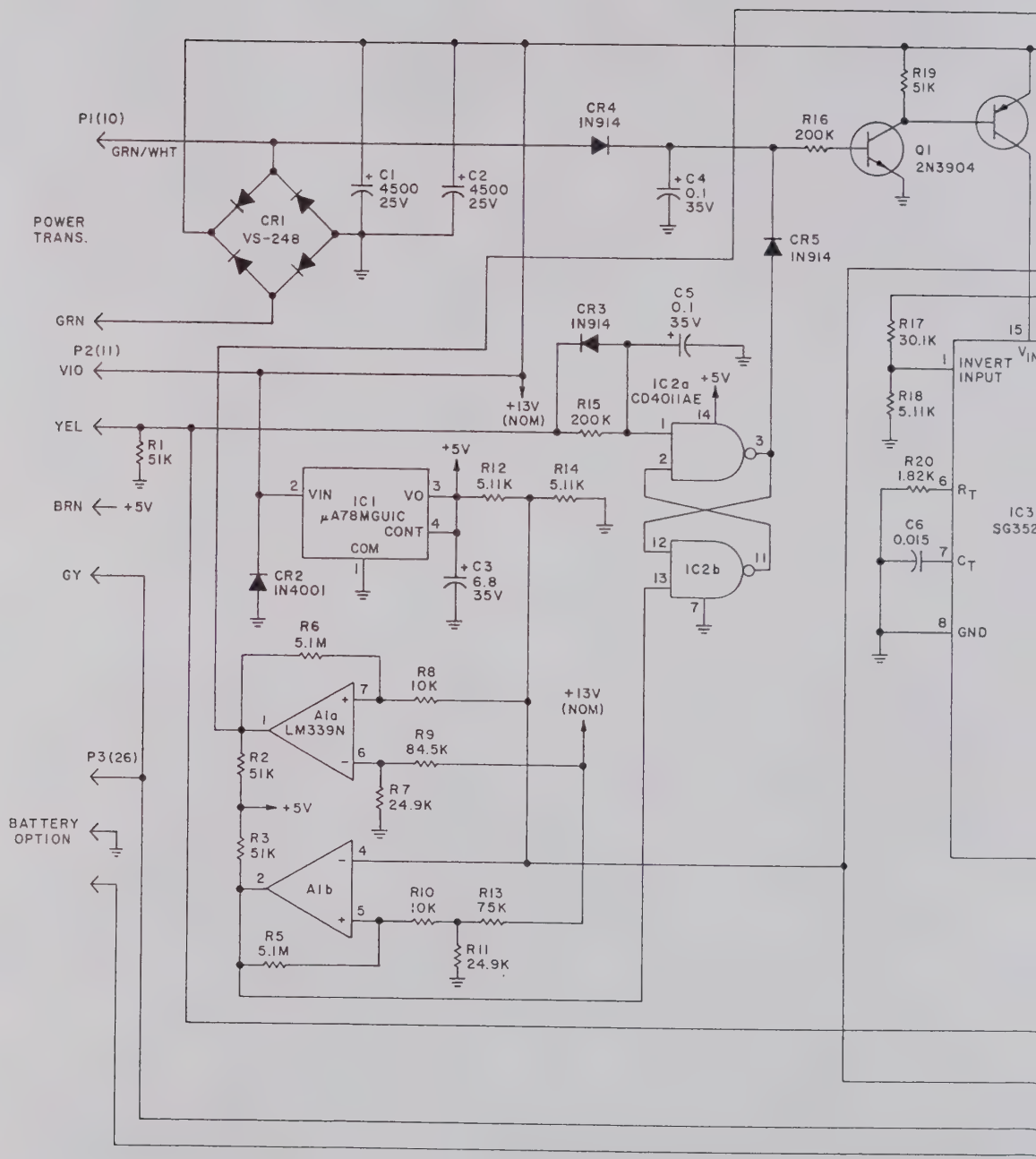
USED ON			TOLERANCES		
4700			2 PLACE DECIMAL .010		
			3 PLACE DECIMAL .005		
			UNLESS OTHERWISE SPECIFIED		
			SCALE: 2:1		
			DRN	TDH	5-27-79
			CKD		
			APP		

BOONTON ELECTRONICS — PARSIPPANY NEW JERSEY

POWER SUPPLY C BOARD OVERLAY

SH OF — C 031072

A7 POWER SUPPLY P.C. BD.

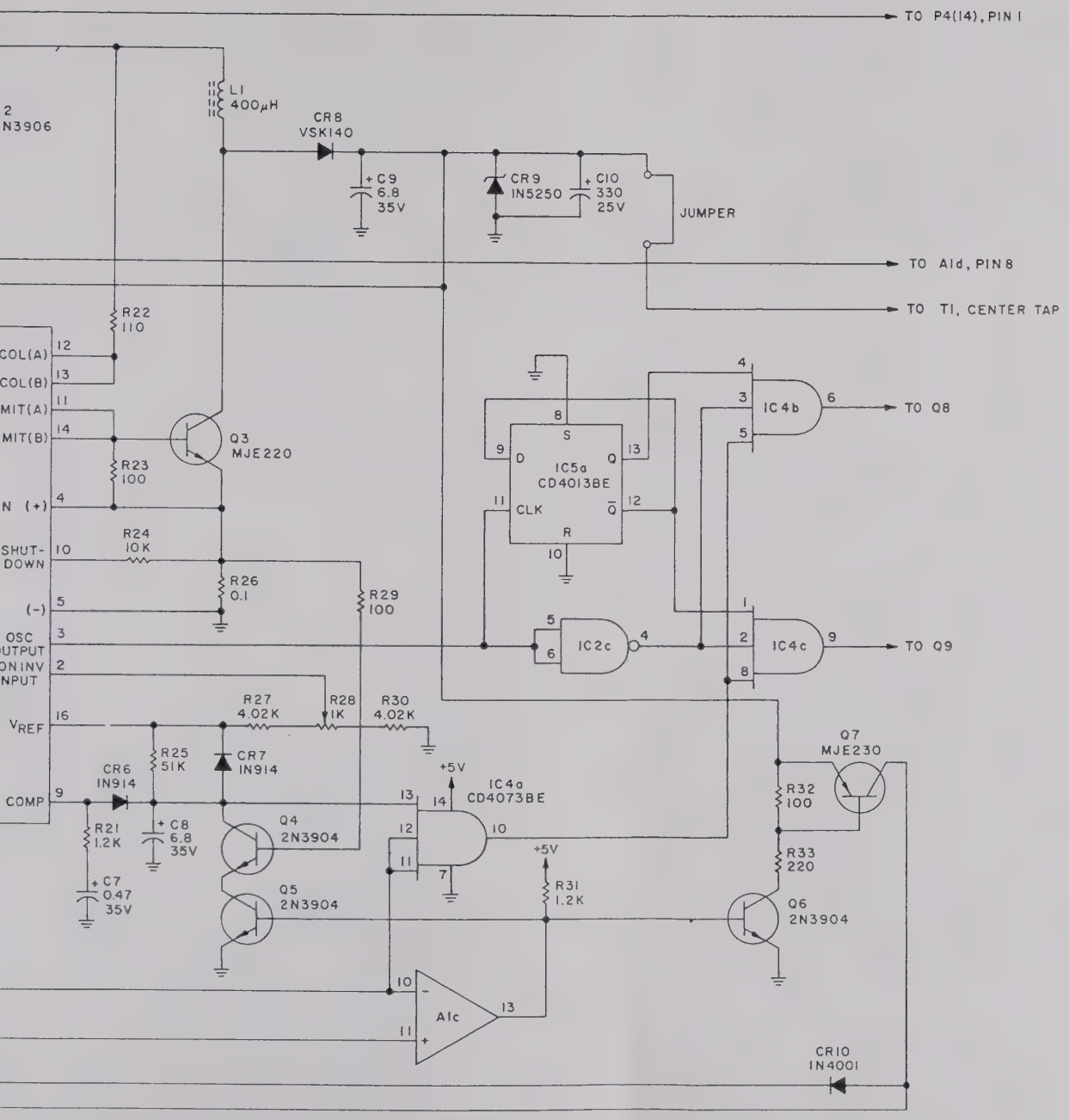


NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED:
   R33 C10 CR10 Q7 IC5
4. NUMBERS NOT USED:
   R4

P1(10)
CONNECTS TO
A1 W10J10(10)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

P2(11
CONNECTS
A1 W11J1
ON FRAME S
8310
SHT. 1

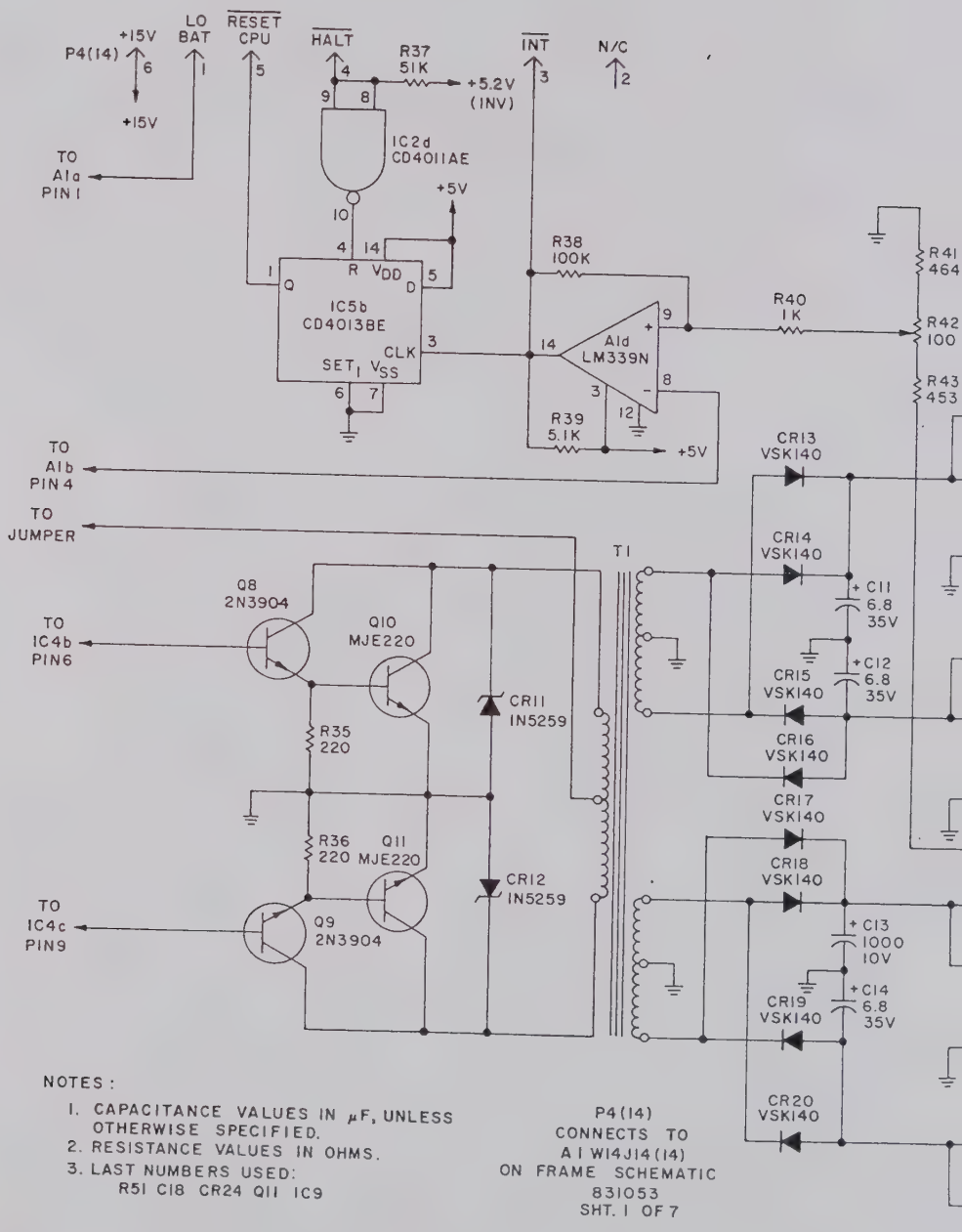


P3(26)
CONNECTS TO
A24 W21 J1(26)
ON FRAME SCHEMATIC
831074
SHT 1 OF 2

BOONTON ELECTRONICS CORPORATION

MODEL 4200, 9200
Schematic, Power Supply PCB
E831053D Sht. 7a of 7

A7 POWER SUPPLY P.C.BD.



NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS.
3. LAST NUMBERS USED:
   R51 C18 CR24 Q11 IC9

P4(14)
CONNECTS TO
A1 W14 J14(14)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

P5(12)
CONNECTS TO
A1 W12 J12(12)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

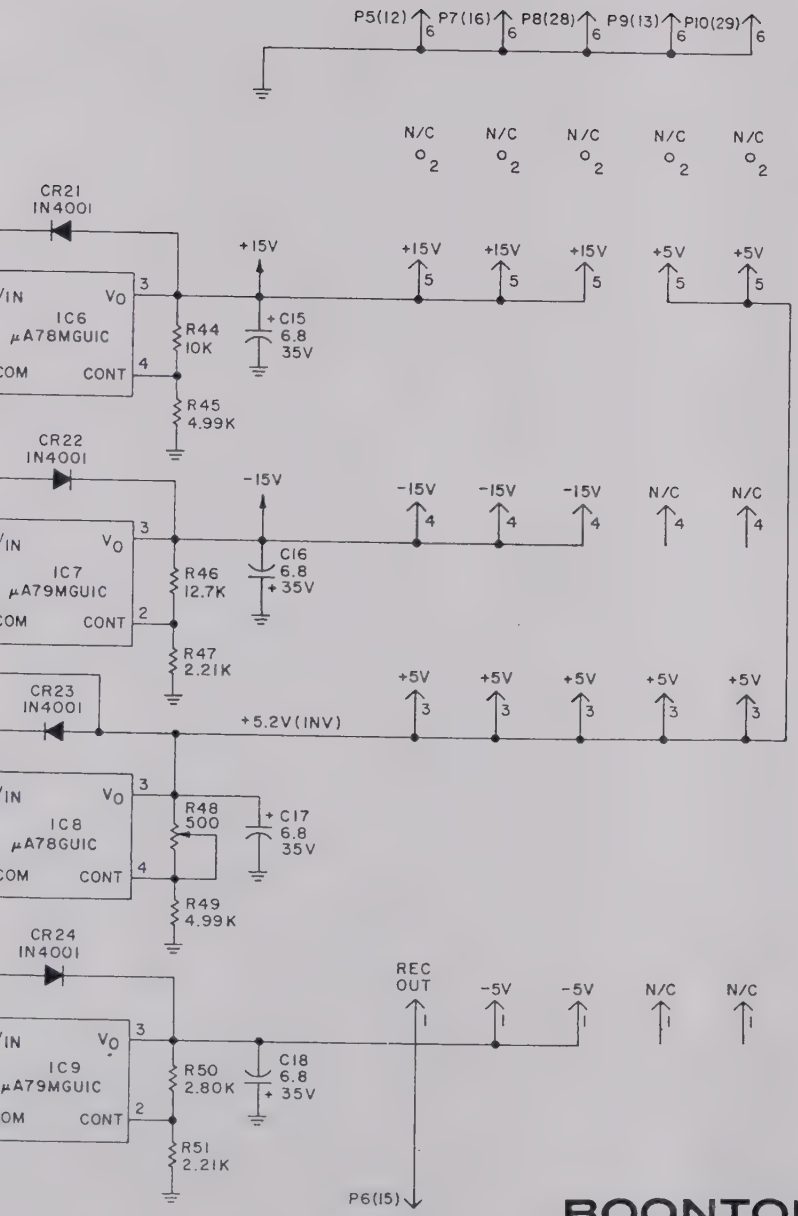
P6(15)
CONNECTS TO
A1 W15 J15(15)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

P7(16)
CONNECTS TO
A1 W16 J16(16)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

P9(13)
CONNECTS TO
A1 W13 J13(13)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

P8(28)
CONNECTS TO
A1 W20 J30(30)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

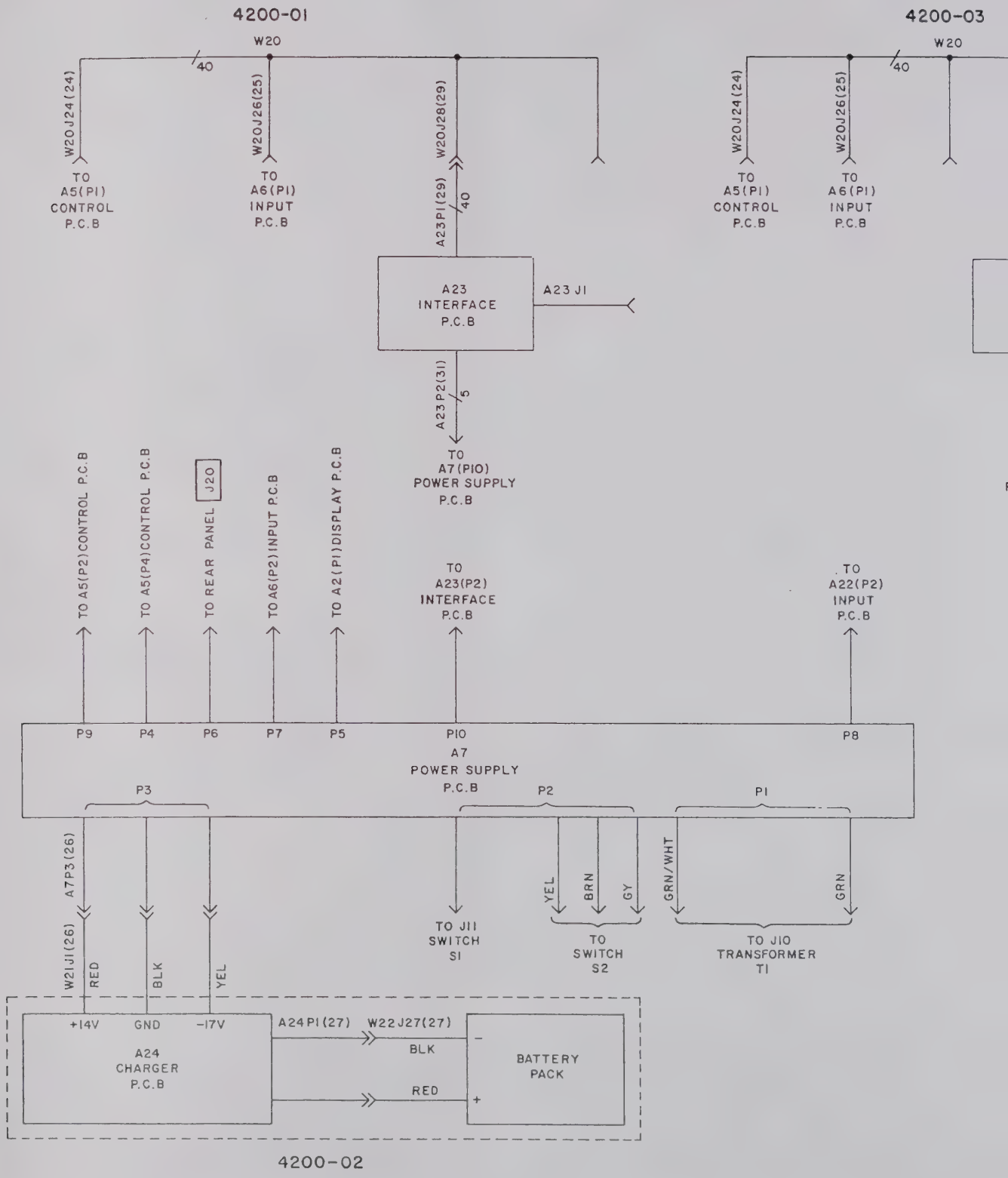
P10(29)
CONNECTS TO
A1 W21 J31(31)
ON FRAME SCHEMATIC
831053
SHT. 1 OF 7

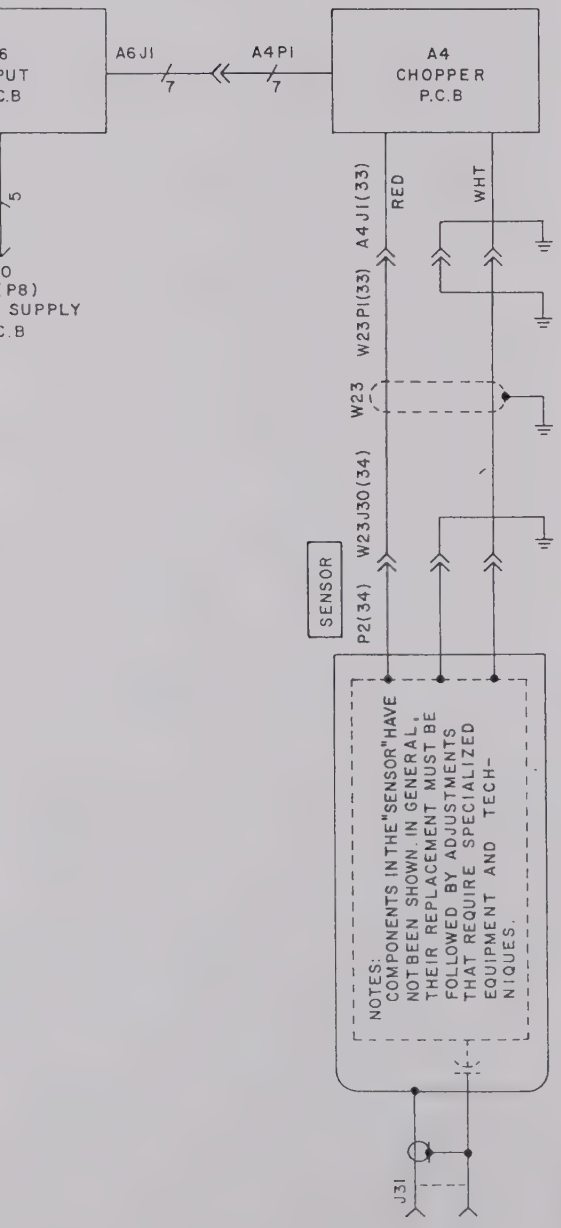


BOONTON ELECTRONICS CORPORATION

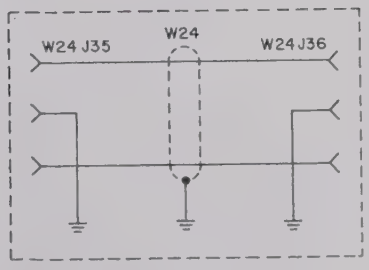
MODEL 4200, 9200
Schematic, Power Supply PCB
D831053D Sht. 7b of 7

A20 MAIN FRAME



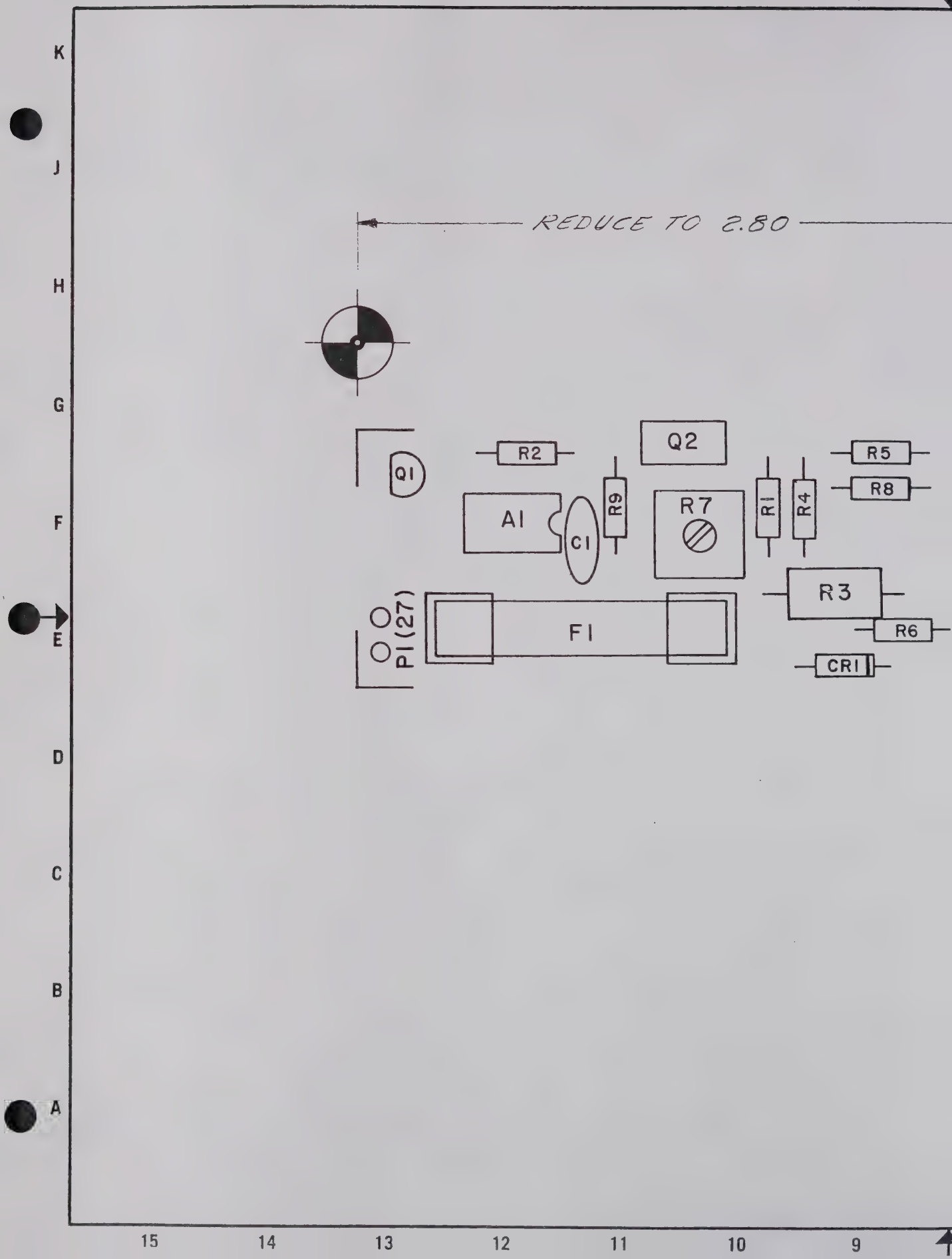


4200-04



BOONTON ELECTRONICS CORPORATION

MODEL 4200-01, -02, -03, -04
Schematic, Options Main Frame
E831099A


REDUCE TO 2.80
Q1
R2
Q2
R5
R8
A1
C1
R9
R7
R1
R4
R3
R6
P1 (27)
F1
CR1
K
J
H
G
F
E
D
C
B
A
15
14
13
12
11
10
9

REVISIONS				
ZONE	REV.	DATE	SIG.	DESCRIPTION
	B	12-5-79 12-6-79 6 DEC 79	T.D.H J.F.D. & K	REVISED OVERLAY TO CHANGES ON TOP ARTWORK. RCN 311
	C	4-10-80 4-11-80 4-11-80	T.D.H J.F.D. AJW	ADDED "(27)" TO P1. RCN 367

USED ON			TOLERANCES		
4200-02			2 PLACE DECIMAL .010 3 PLACE DECIMAL .005 UNLESS OTHERWISE SPECIFIED		
9200-02					
			SCALE: 2:1		
			DRN	T.D.H	10-22-79
			CKD	J.F.D.	11-13-79
			APP	A.P.L.	11-21-79

BOONTON ELECTRONICS CORPORATION
PARSIPPANY NEW JERSEY

CHARGER P.C. BOARD OVERLAY

SIZE C

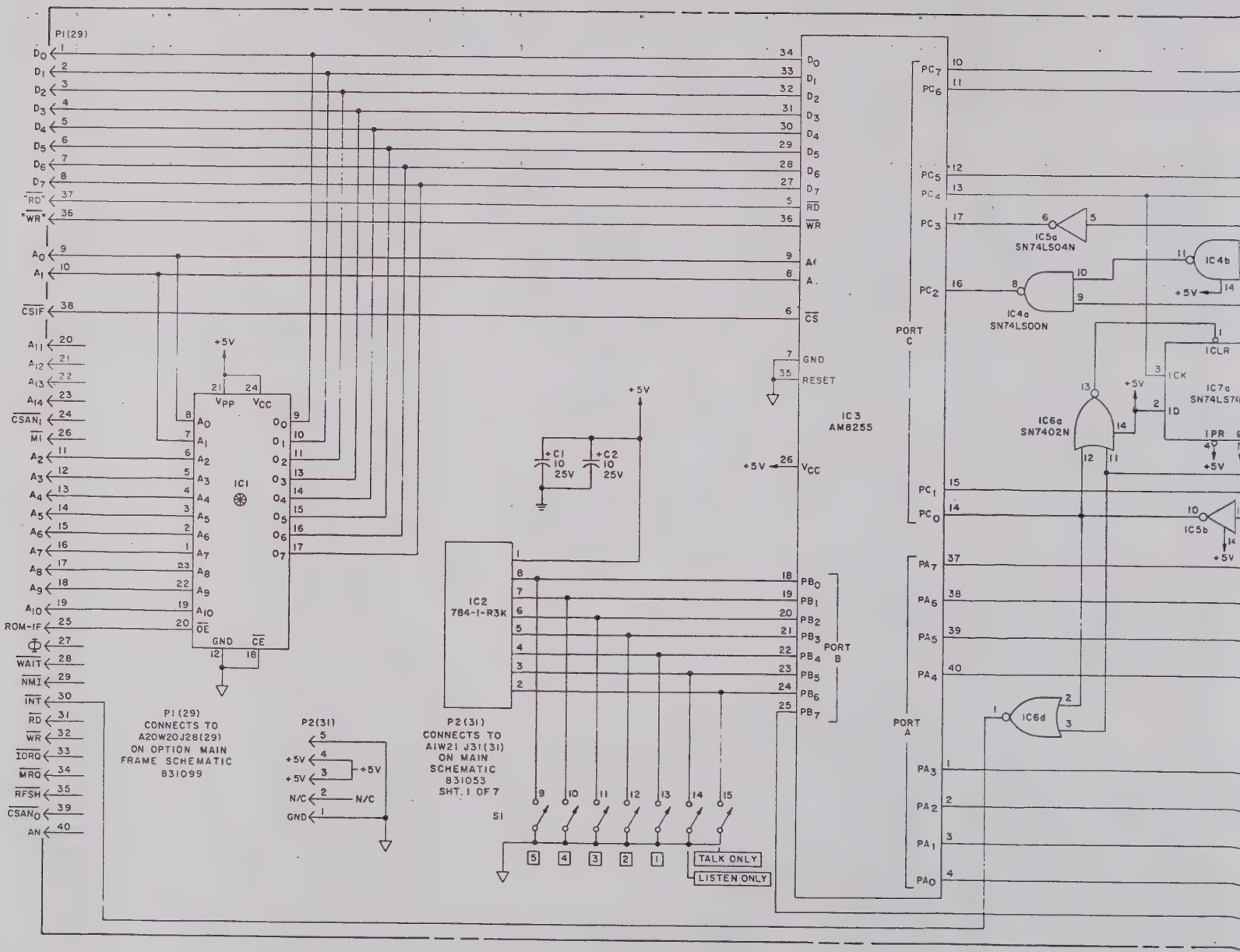
SH. OF

B 831075

7 6 5 4 3 2 1

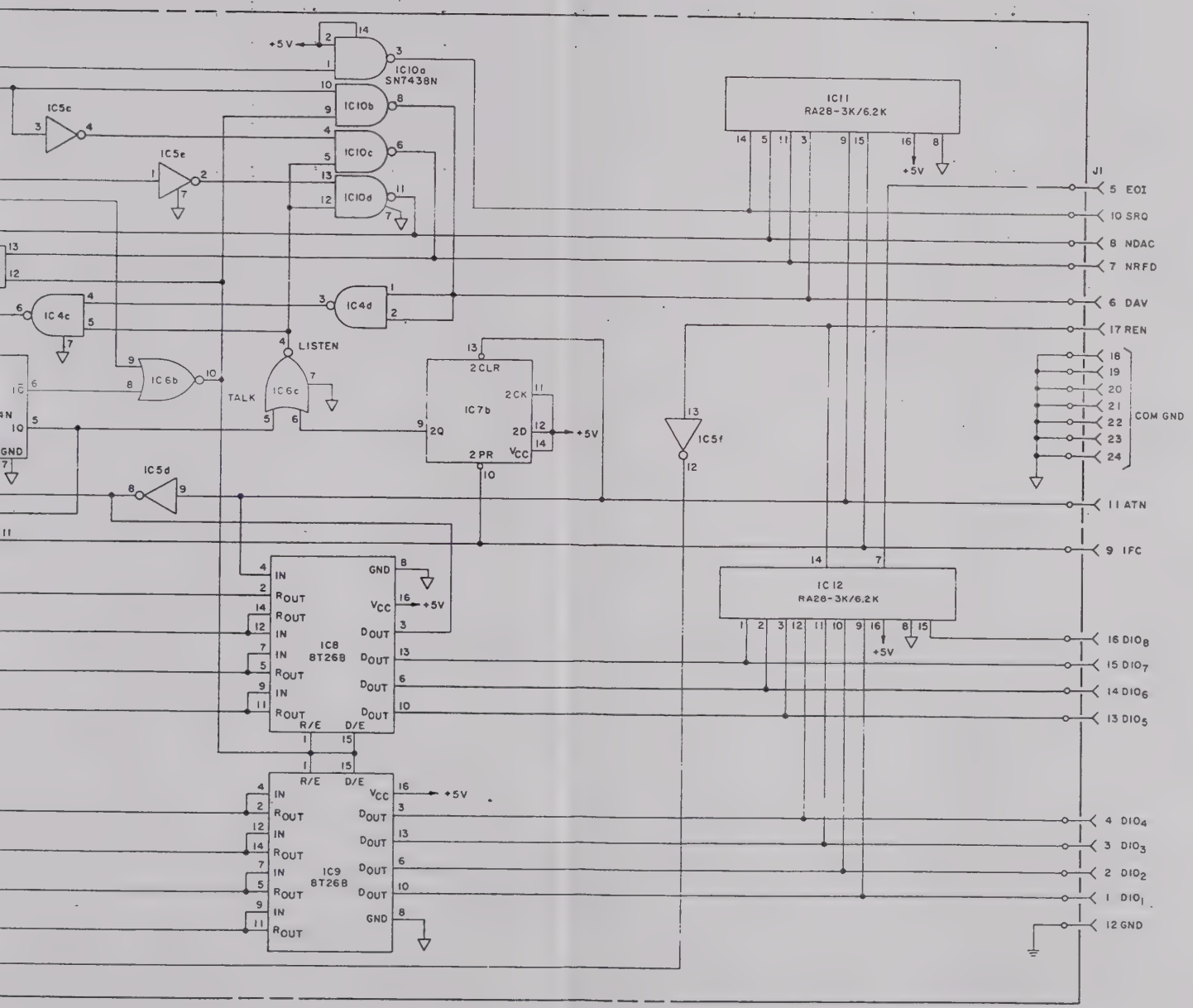
K J H G F E D C B A

A23 INTERFACE P.C. BOARD



NOTES:

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. ☐ EXTERNAL MARKINGS.
3. LAST NUMBERS USED: IC12
4. ⊛ SELECTED VALUE



BOONTON ELECTRONICS CORPORATION

MODEL 4200-01
Schematic, Interface PCB
R831074A

32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17

REDUCE TO 10.05

C2

J1

12
11
10
9
8
7
6
5
4
3
2
1

P2(32)

IC12

IC8

IC9

IC11

IC10

IC5

IC3

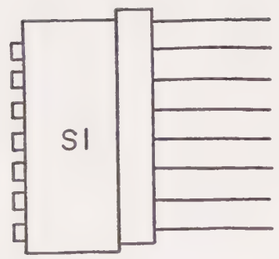
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

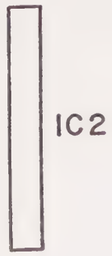
REVISIONS				
ZONE	REV.	DATE	SIG.	DESCRIPTION
C-2B	B	1-25-80 1-25-80 1-28-80	T.D.H J.F.D. M.W.	RELOCATED "P2" TO CLEAR MOUNTING BRACKET.
	C	3-12-80 3-28-80	T.D.H J.F.D.	ADDED "(29)" TO P1 & "(32)" TO P2.

Y W V U T S R P N M L

ICI

1
3
5
7
9
11
13
15
17


S1


IC2

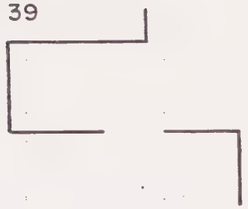
+
C1

IC7

IC4

IC6

23
25
27
29
31
33
35
37
39



USED ON			TOLERANCES		
4200-01			2 PLACE DECIMAL .010 3 PLACE DECIMAL .005 UNLESS OTHERWISE SPECIFIED		
4200-06			SCALE: 2:1		
			DRN	B.S.	4-10-79
			CKD	T.D.H	5-4-79
			APP	J. H.	1-28-80

BOONTON ELECTRONICS CORPORATION PARSIPPANY, NEW JERSEY

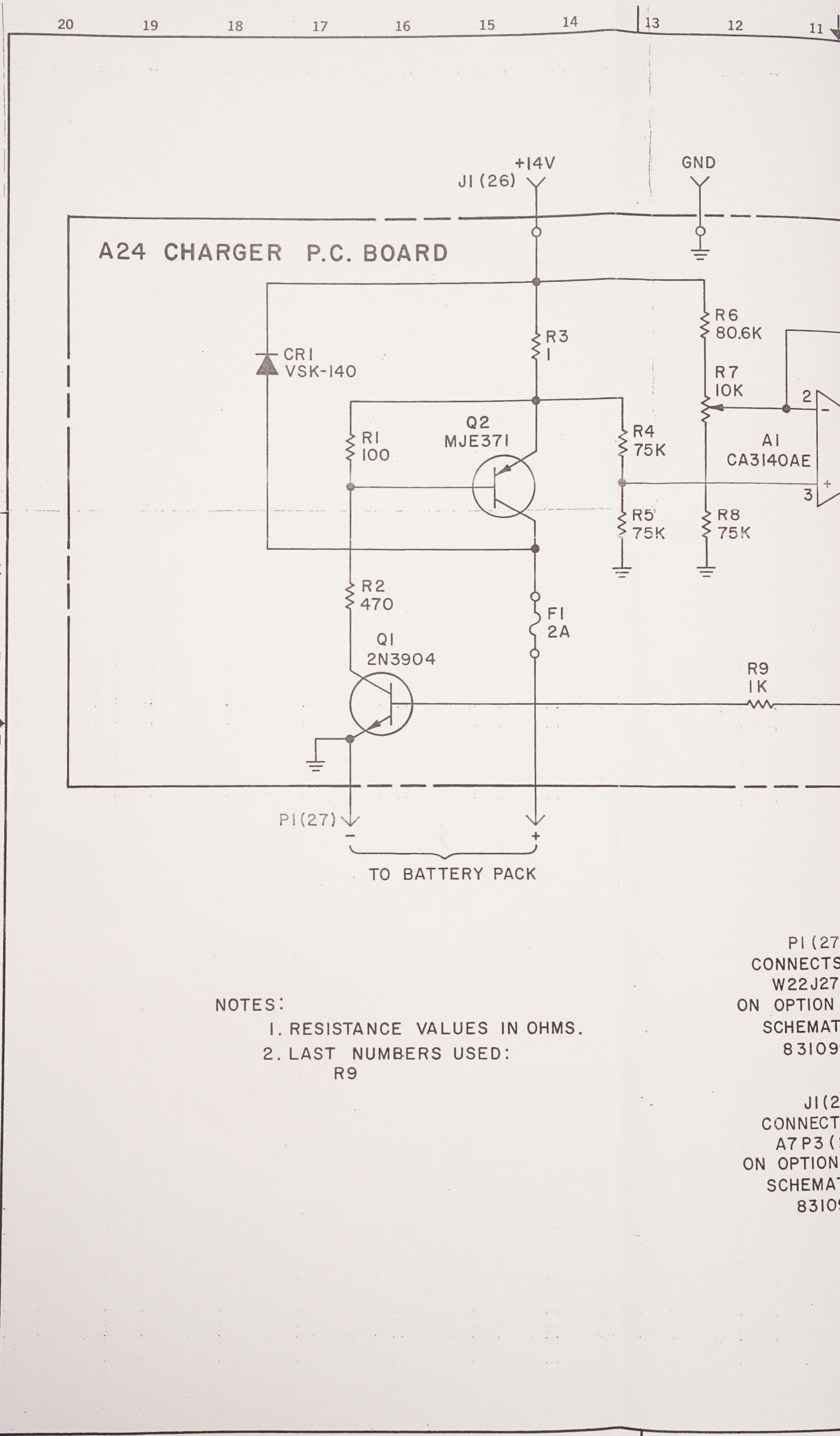
INTERFACE P.C. BOARD OVERLAY

SH. OF D 831069

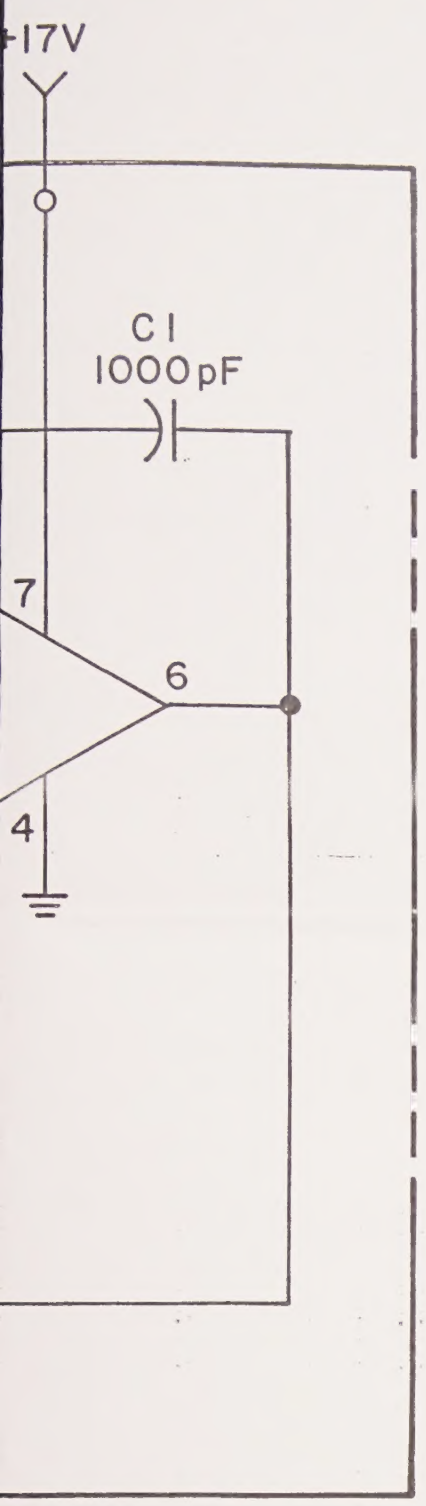
C

A

16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1


+14V
J1 (26)
GND
A24 CHARGER P.C. BOARD
CR1
VSK-140
R3
1
R6
80.6K
R7
10K
2
3
A1
CA3140AE
Q2
MJE371
R1
100
R4
75K
R5
75K
R8
75K
R2
470
F1
2A
Q1
2N3904
R9
1K
P1(27)
TO BATTERY PACK
NOTES:
1. RESISTANCE VALUES IN OHMS.
2. LAST NUMBERS USED:
R9
P1(27
CONNECTS
W22J27
ON OPTION
SCHEMAT
83109
J1(2
CONNECT
A7P3(
ON OPTION
SCHEMA
8310

REVISIONS				
ZONE	REV.	DATE	SIG.	DESCRIPTION
	B	4-10-80 4-11-80 4-11-80	T.D.H J.F.D. AR dw	REVISED "P1" & "J1" CONNECTION NOTES. ADDED "A24" TO SCHEMATIC TITLE. RCN 367
N-17	C	6-13-80 6-18-80 8 JUL 80	AR JFD EK	CR1 (VSK-140) WAS IN4001 RCN 384



TO
7)
RAME
C

TO
)
RAME
C

USED ON			TOLERANCES		
4200-02			2 PLACE DECIMAL .010 3 PLACE DECIMAL .005 UNLESS OTHERWISE SPECIFIED		
9200-02			SCALE:		
			DRN	T.D.H	10-19-79
			CKD	J.F.D.	11-12-79
			APP	H.A.K.	11-21-79

BOONTON ELECTRONICS CORPORATION PARSIPPANY NEW JERSEY

SCHEMATIC, CHARGER P.C.B.

C

SH. 1 OF 2

C 831071

B

MP MASTER
MA24750